

Assembly of Crab Cavities Fundamental Power Couplers in SM18 clean room

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on behalf of BE-RF-PM section members

With inputs from

Ilan Ben Zvi (BNL)

Thomas Jones (STFC)

Karl Schirm, Alick Macpherson, Giovanna Vandoni, Mathieu Therasse, Gabriel
Pechaud, Max Gourragne, Sauro Bizzaglia (BE-RF-SFR team)

Ofelia Capatina, Pierre Minginette and Teddy Capelli (EN-MME-EDM)

Preamble

All presented proposals have been made with inputs of experts that we wish to thank

Ilan Ben Zvi – BNL

Thomas Jones – STFC

Karl Schirm, Alick Macpherson, Giovanna Vandoni, Gabriel Pechaud, Max Gourragne, Sauro Bizzaglia – BE-RF-SRF SM18 clean room

Ofelia Capatina, Pierre Minginette, Teddy Capelli – EN-MME-EDM

The proposals match with the existing structure of the cleanrooms and any material will be validated by the BE-RF-SRF team

Preamble

The Fundamental Power Coupler team BE-RF-PM will be trained to assist the BE-RF-SFR team during the assembly of the FPC

Romuald Terry did participate in the LHC couplers mounting onto LHC cavities in SM18 cleanroom facilities, and is asked to help the SRF team when needed

Sebastien Calvo did participate in the SPL coupler mounting in CEA l'Orme Les Meurisiens clean room facilities, and in the ESRF couplers in ESRF clean room facilities

Eight other PM team members will be trained in the coming weeks in order to provide help if requested

At any stage, PM team will be 'assisting' SRF experienced experts that will always lead the tasks in clean room



Romuald & Seb



Global Workflow

All parts come from the chemistry (build. 102) degreased and individually bagged in plastic bag

All soldered or EBW parts will always follow a "clean" process (packaging and handling with gloves)

All sets will be re-washed manually before entering baldaquin/cleanroom

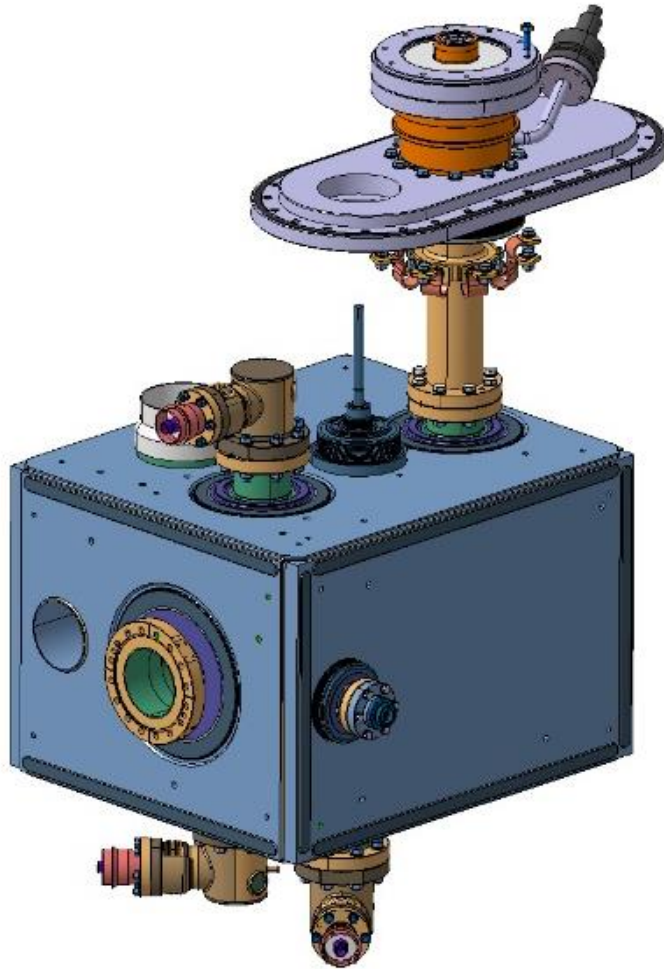
Colours define provider groups

BE/RF/PM

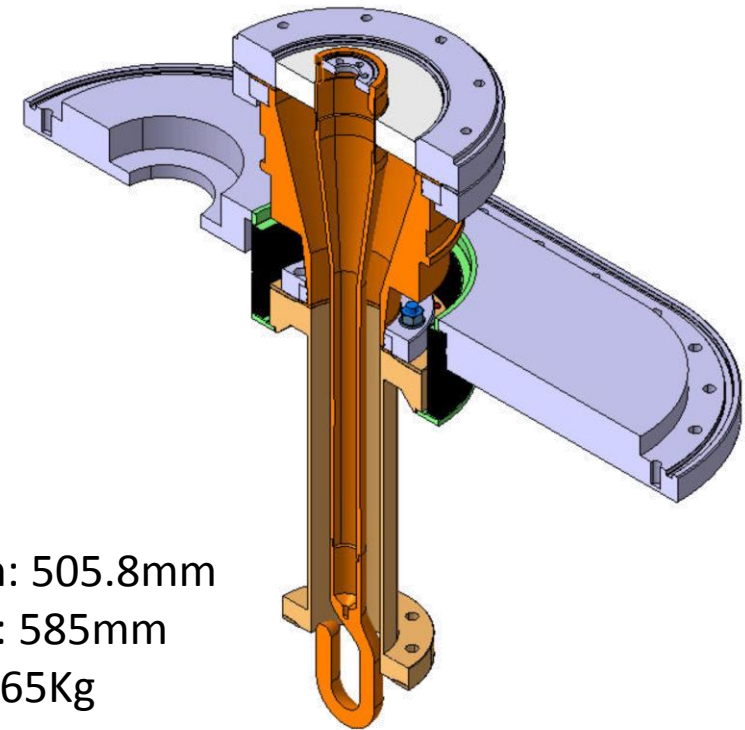
BE/RF/SRF

EN/MME

What to be assembled ?



2 x 1 FPC
(Fundamental Power Coupler)



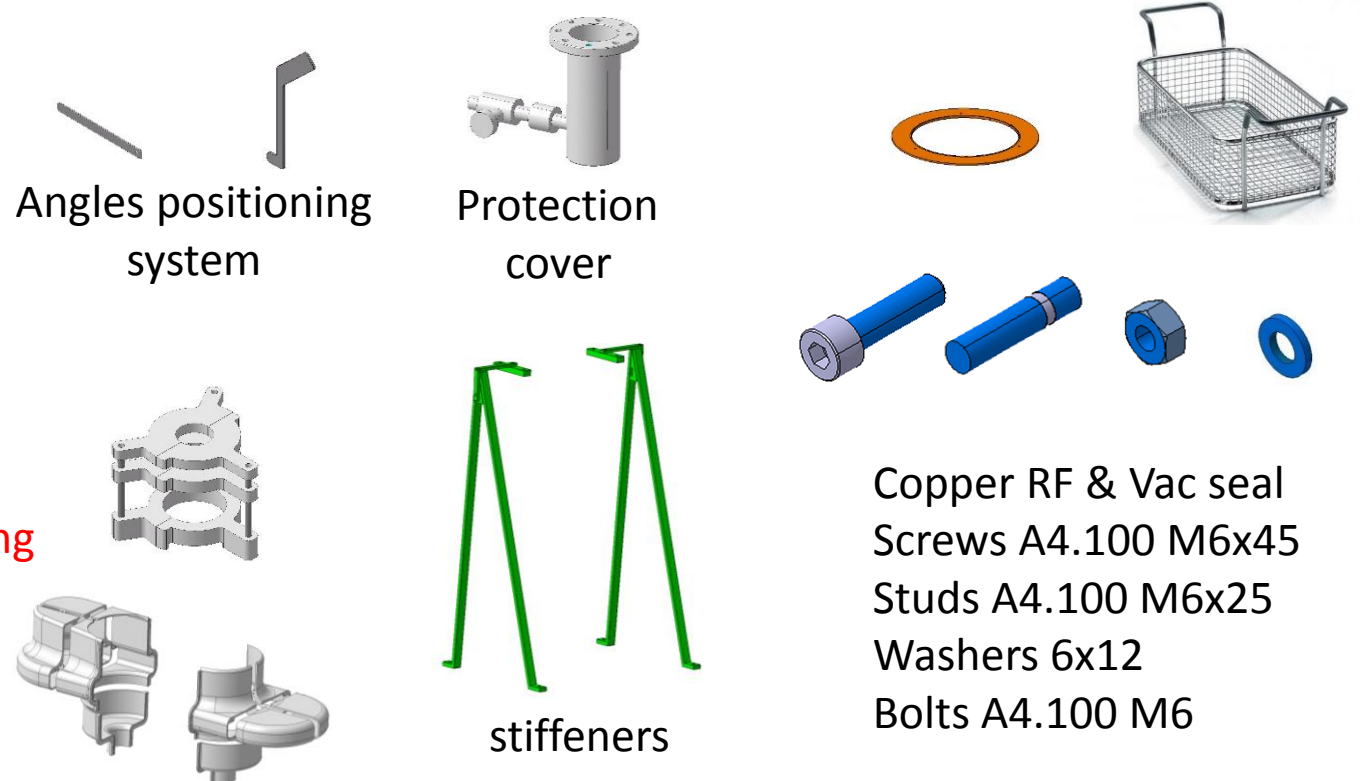
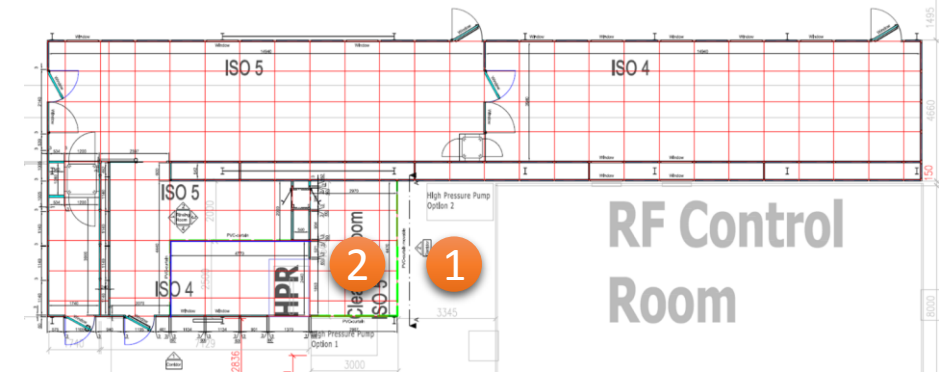
Length: 505.8mm
Width: 585mm
Mass: 65Kg

Accessories

Accessories

Description	Area	Time
Delivery of accessories, nuts, bolts, washers and copper seals... packed by the Chemists experts in plastic bag	1	Day1
Blow with pure air	1	
Go to clean room ISO 5	2	
Blow with pure air and open the plastic bag	2	

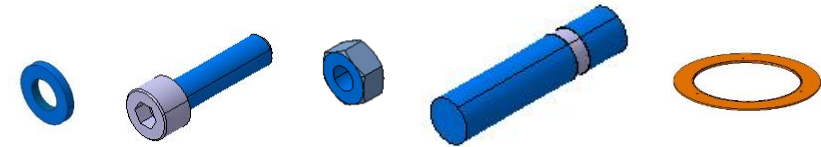
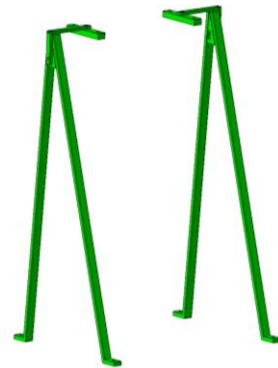
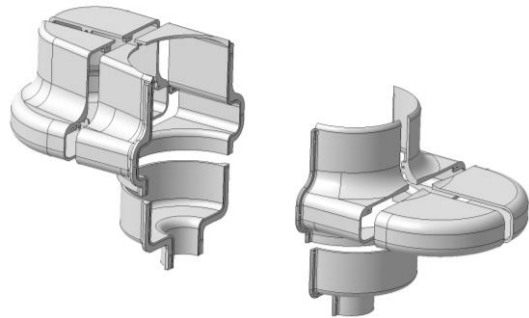
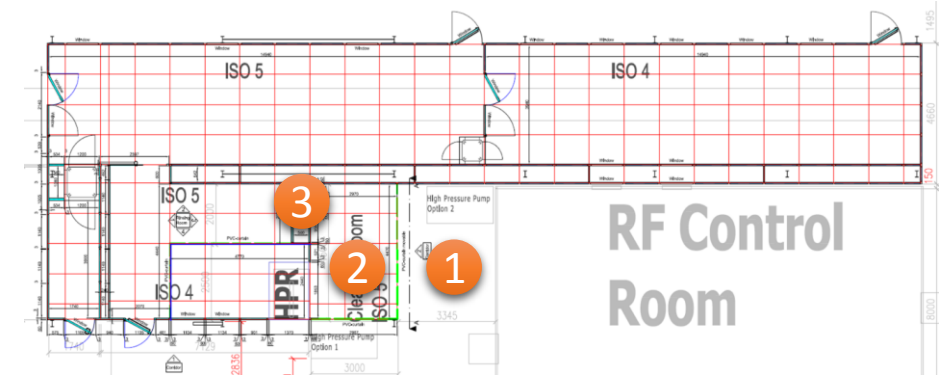
Positioning system and protecting cover design on going
 Accura 25 qualified (Mathieu) & Stainless Steel
 Sliding parts as far as possible from the aperture
 System still to be tested and qualified



Copper RF & Vac seal
 Screws A4.100 M6x45
 Studs A4.100 M6x25
 Washers 6x12
 Bolts A4.100 M6

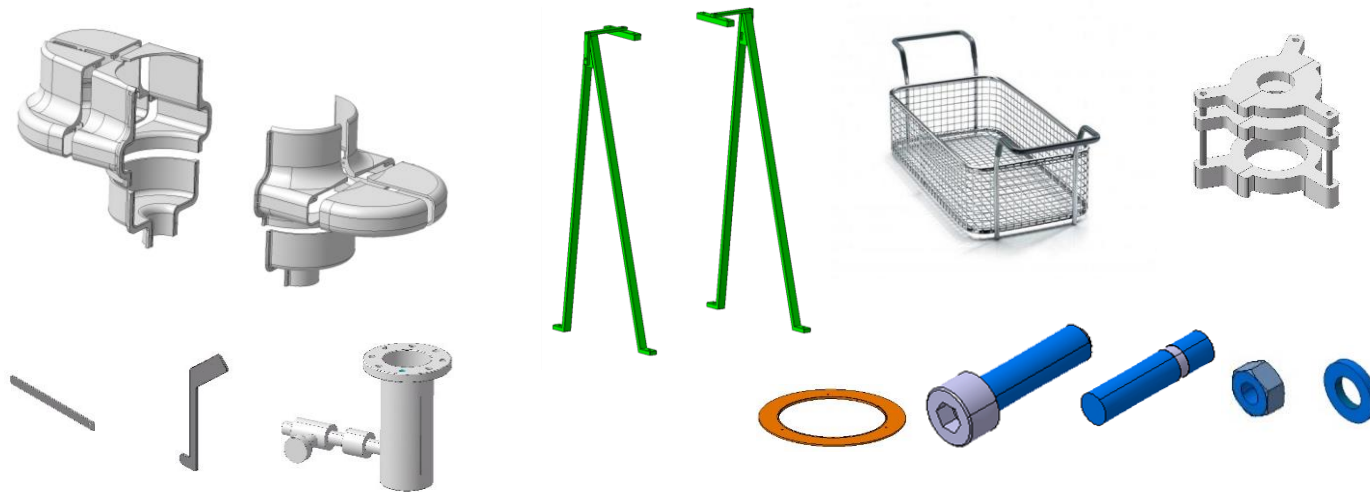
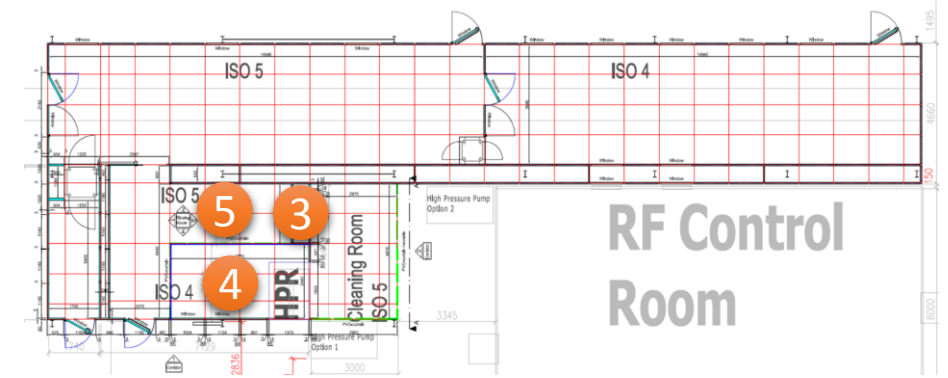
Particles counting

Description	Area	Time
Dry with pure air	2	Day1
Keep under laminar flux	2	Night 1
Blow and particles counting	2	Day2
Put all of them in the SAS	3	

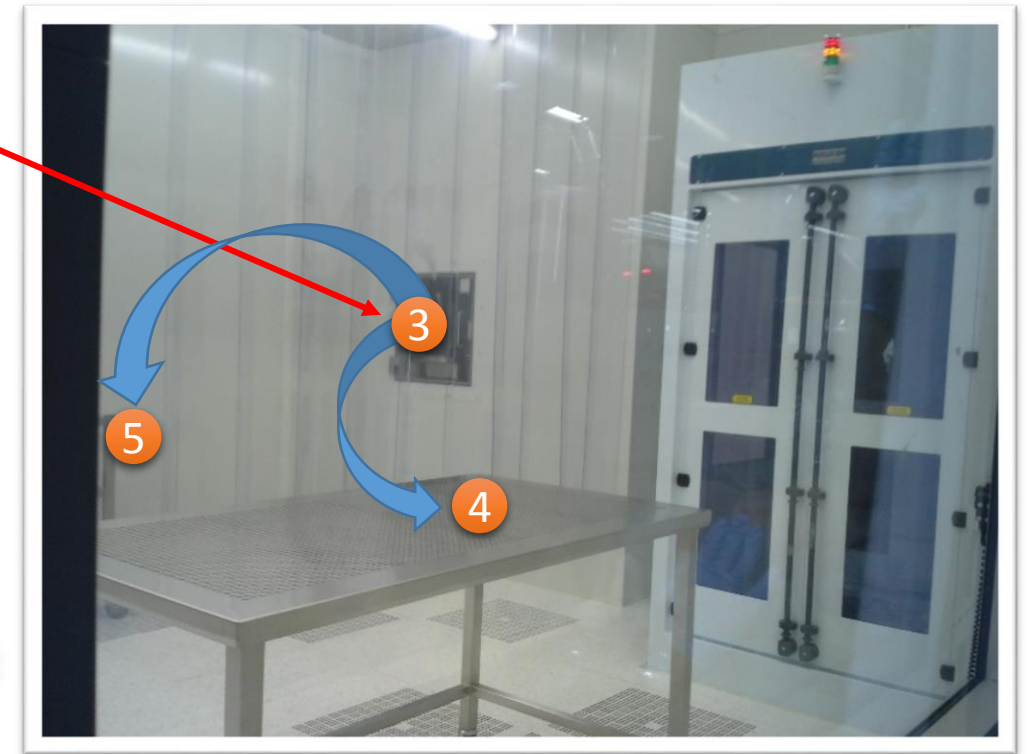


Moving to ISO4

Description	Area	Time
Move all components to be assembled from the SAS to ISO4 area	4	Day3
Store the other components in storage ISO5 area	5	



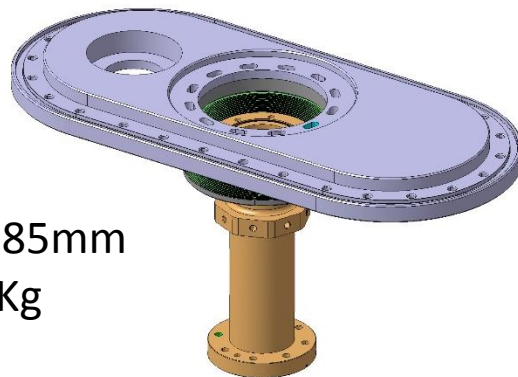
SAS



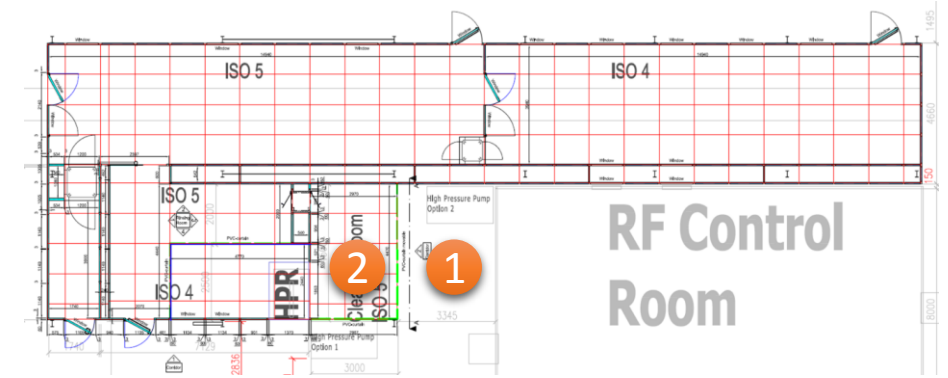
FPC Outer Line

FPC Outer Line from bulk

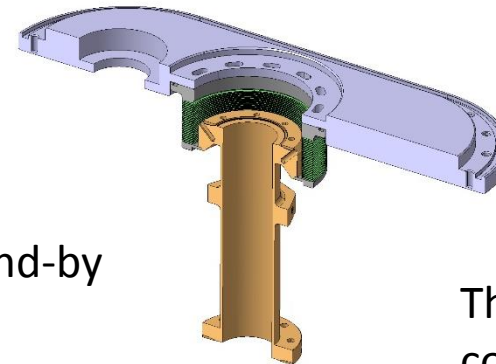
Description	Area	Time
Delivery of the compressed Outer Line packed by the Chemists experts in plastic bag	1	Day1
Blow with pure air	1	
Go to clean room ISO 5	2	
Blow with pure air and open the plastic bag	2	



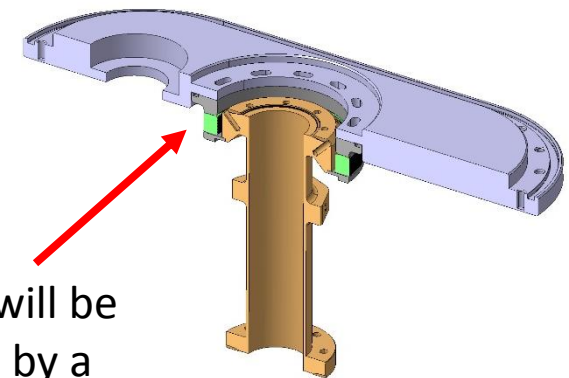
Length: 585mm
Mass: 35Kg



Stand-by

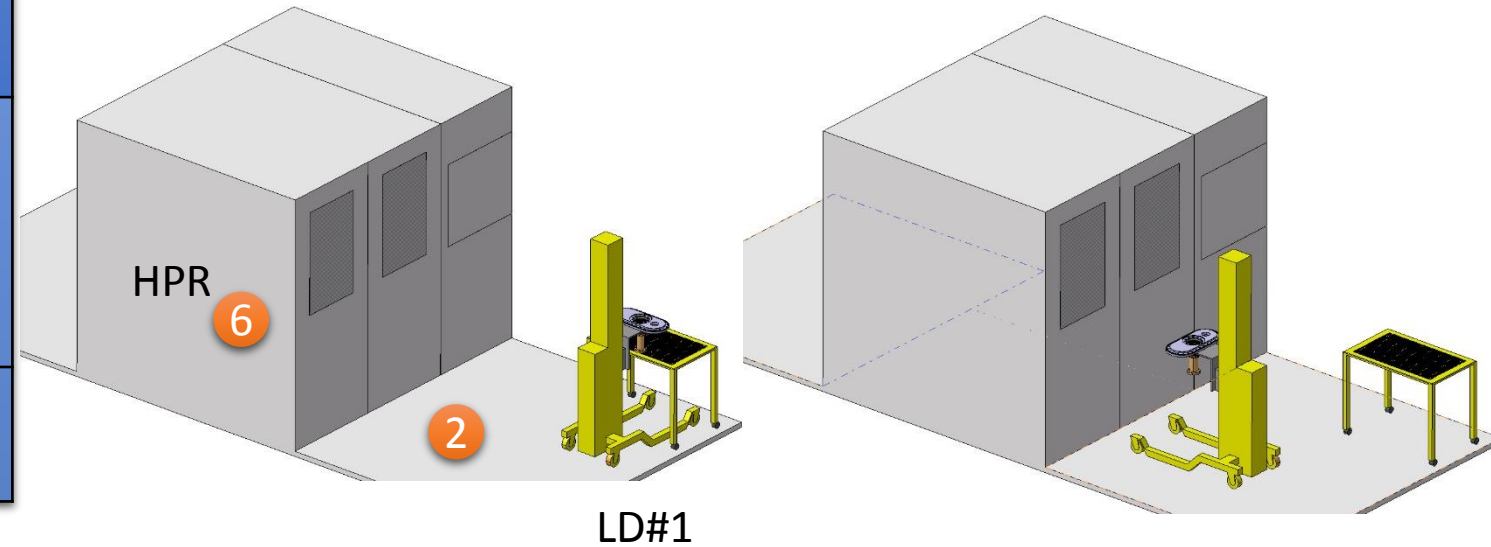
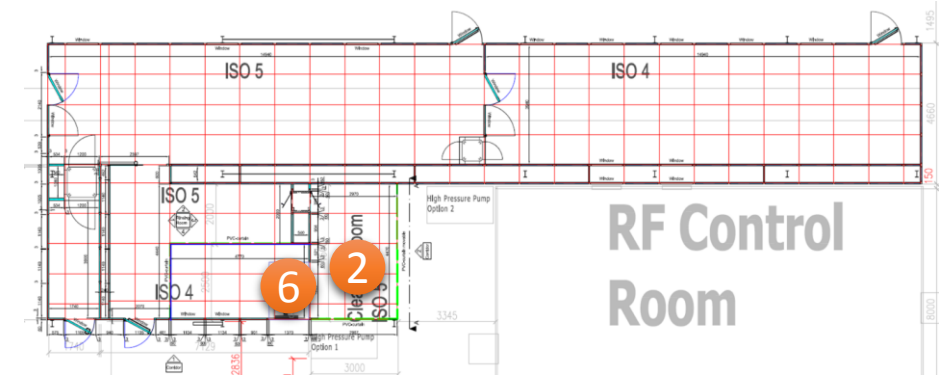


The bellow will be compressed by a special system provided by EN-MME

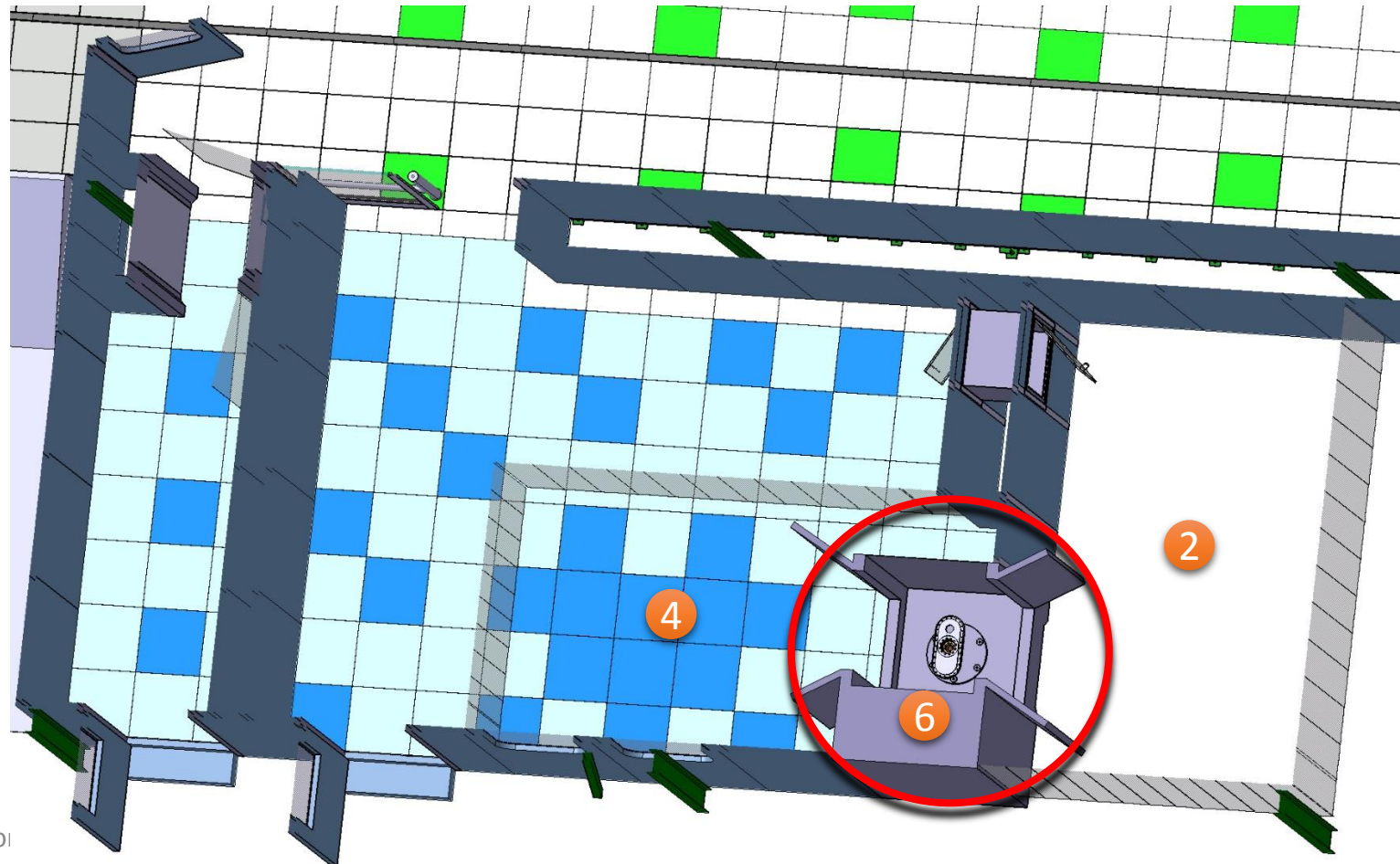
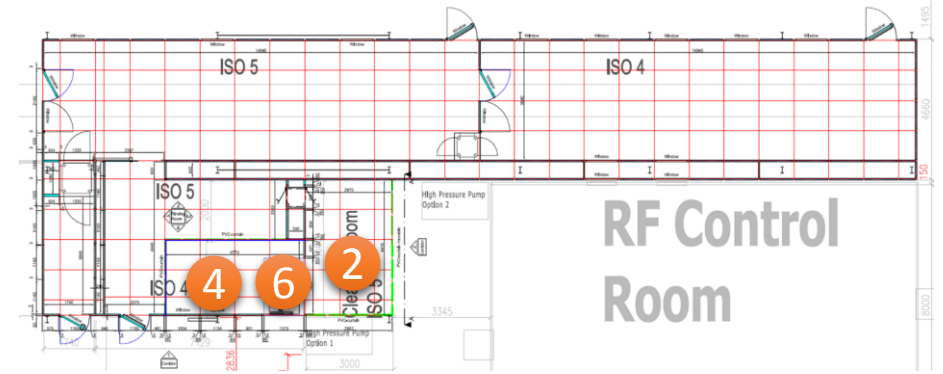


Moving to HPR

Description	Area	Time
Dry with pure air	2	Day1
Keep under laminar flux	2	Night 1
Blow and particles counting	2	Day2
Go to HPR with Lifting Device#1 and apply 20bars during 10min	6	
Keep under laminar flux	6	Night 2



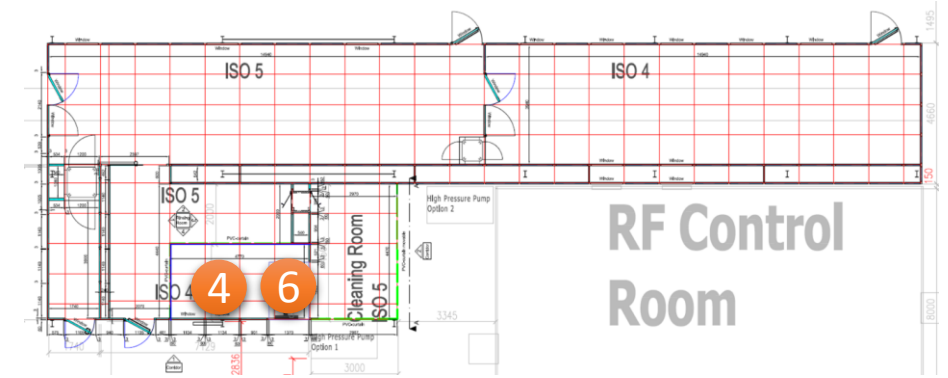
FPC Outer Line in HPR



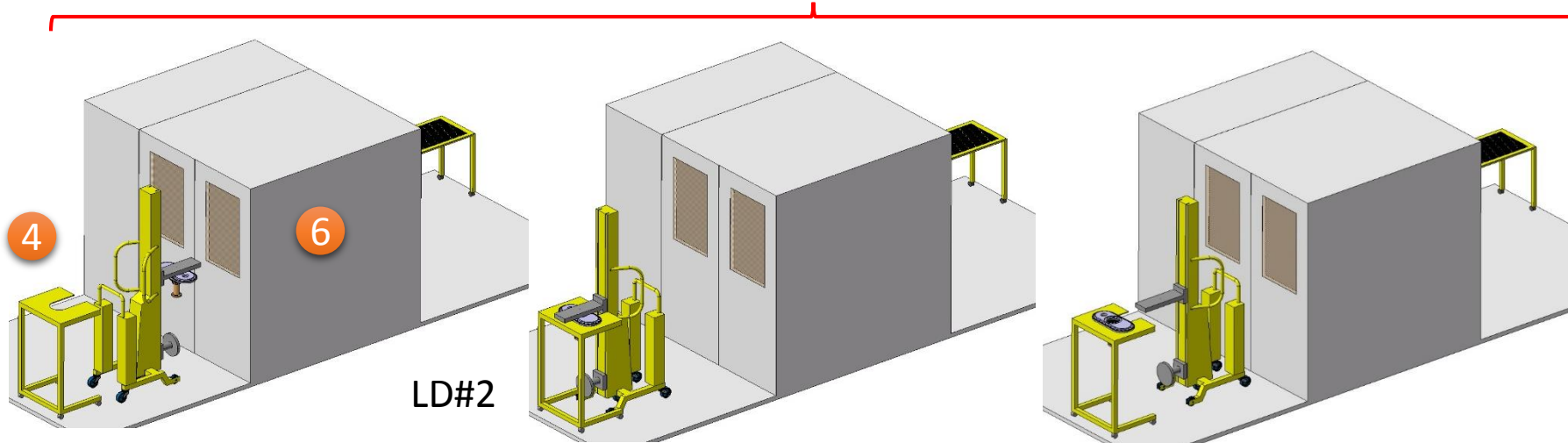
The size of the Outer Line is compatible with the HPR box

Moving to ISO4

Description	Area	Time
Take the Outer Line from HPR with Lifting Device#2	6	Day3
Move Outer Lines on their supports in ISO4 area	4	



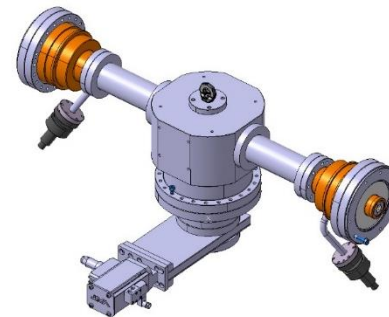
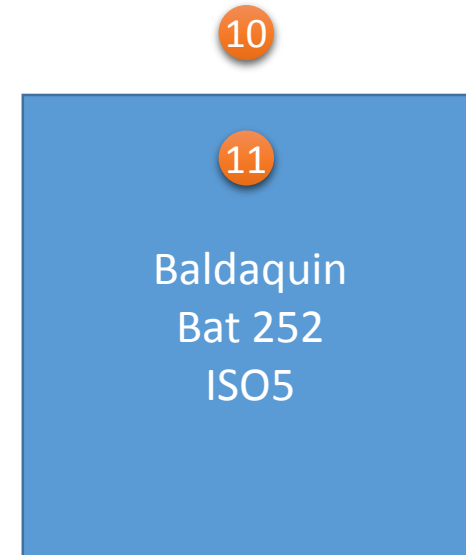
x2



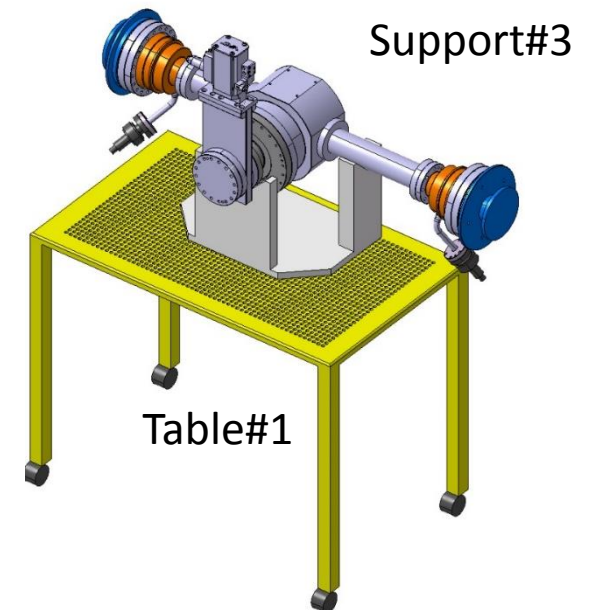
FPC from Test Box

FPC from 252 to SM18

Description	Area	Time
Test box & FPC is under argon (ATM+0.2bar)	10	Day1
Move test box & FPC onto support#3 on table#1	10	
Clean with clean room tissues and isopropyl alcohol 70%	10	
Move inside baldaquin (ISO5)	11	
Clean again external faces with clean room tissues and isopropyl alcohol 70%	11	
Rinse with demineralized ultra pure water with high pressure system gun (7bars)	11	
Dry with pure air	11	



Length: 1100mm
Mass: 95Kg

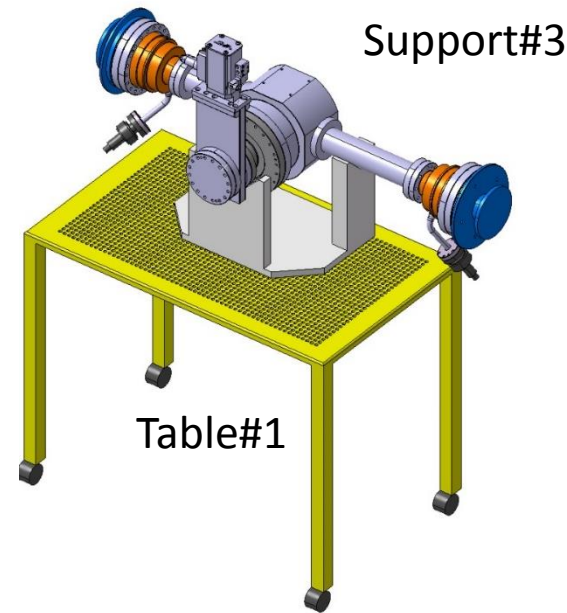


FPC from 252 to SM18

Description	Area	Time
Keep under laminar flux	11	Nigth 1
Blow and particles count with	11	Day2
Pack the 2 FPC and test box with 2 layers of plastic bags	11	

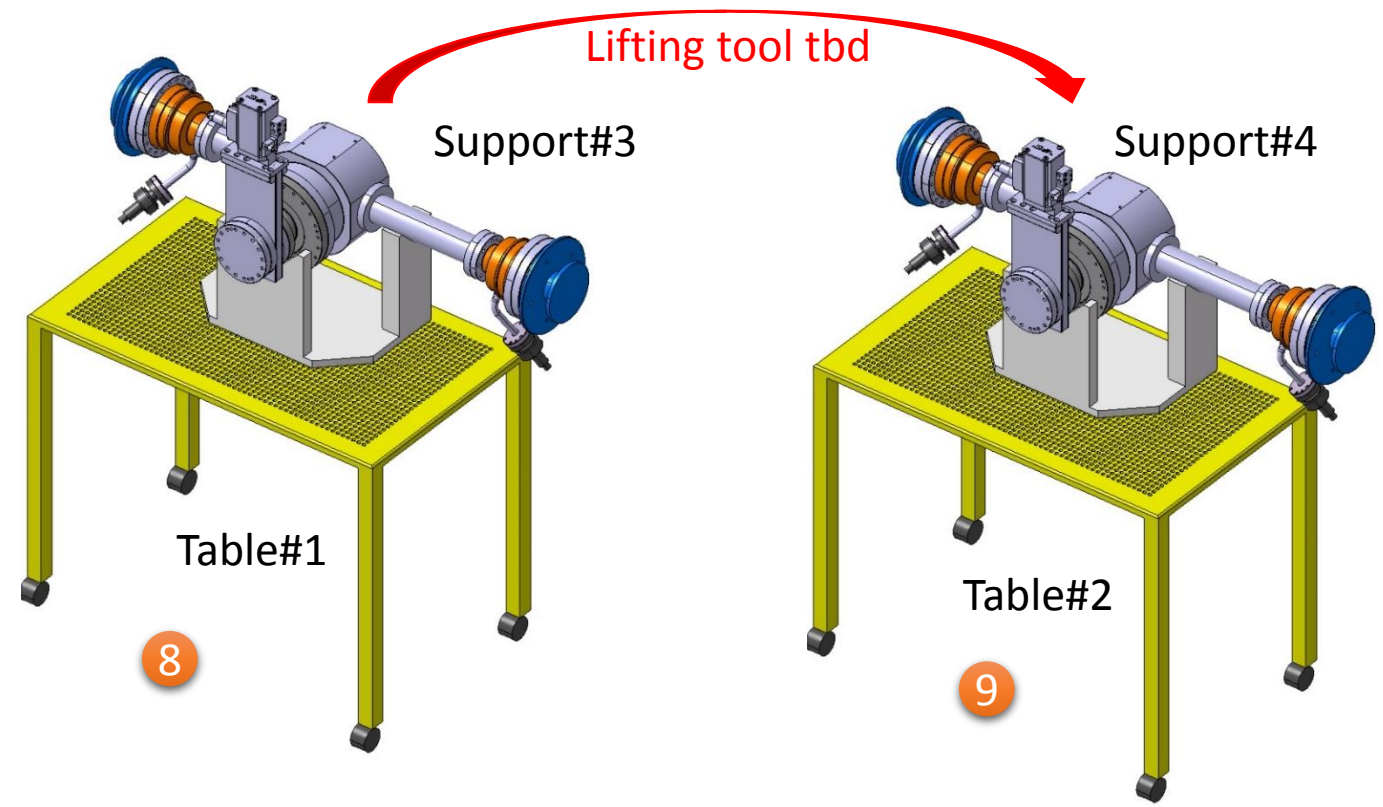
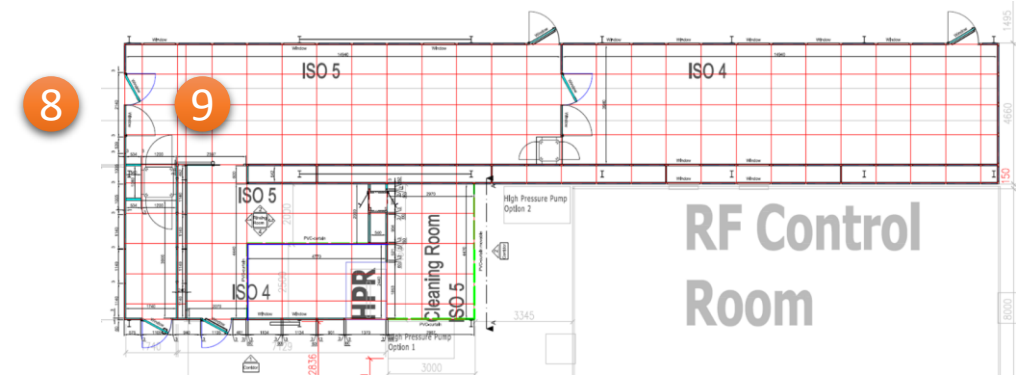
11

Baldaquin
Bat 252
ISO5



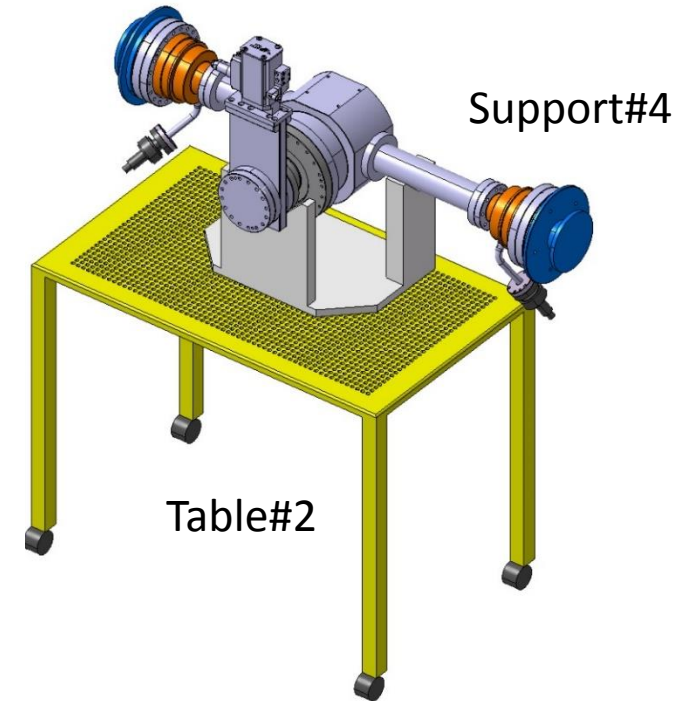
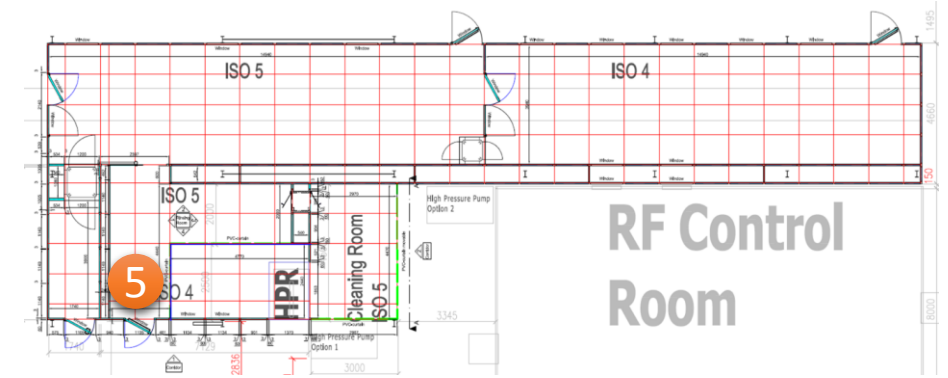
Moving to ISO5

Description	Area	Time
Transport the assembly in front of clean room ISO5	8	Day2
Dry with pure air the 1 st layer of plastic bag	8	Day3
Open the door and enter in clean room ISO5 and move the Test Box on support#4 table#2	9	
Remove the 1 st layer of plastic bag	9	
Blow with pure air the 2 nd layer of plastic bag	9	



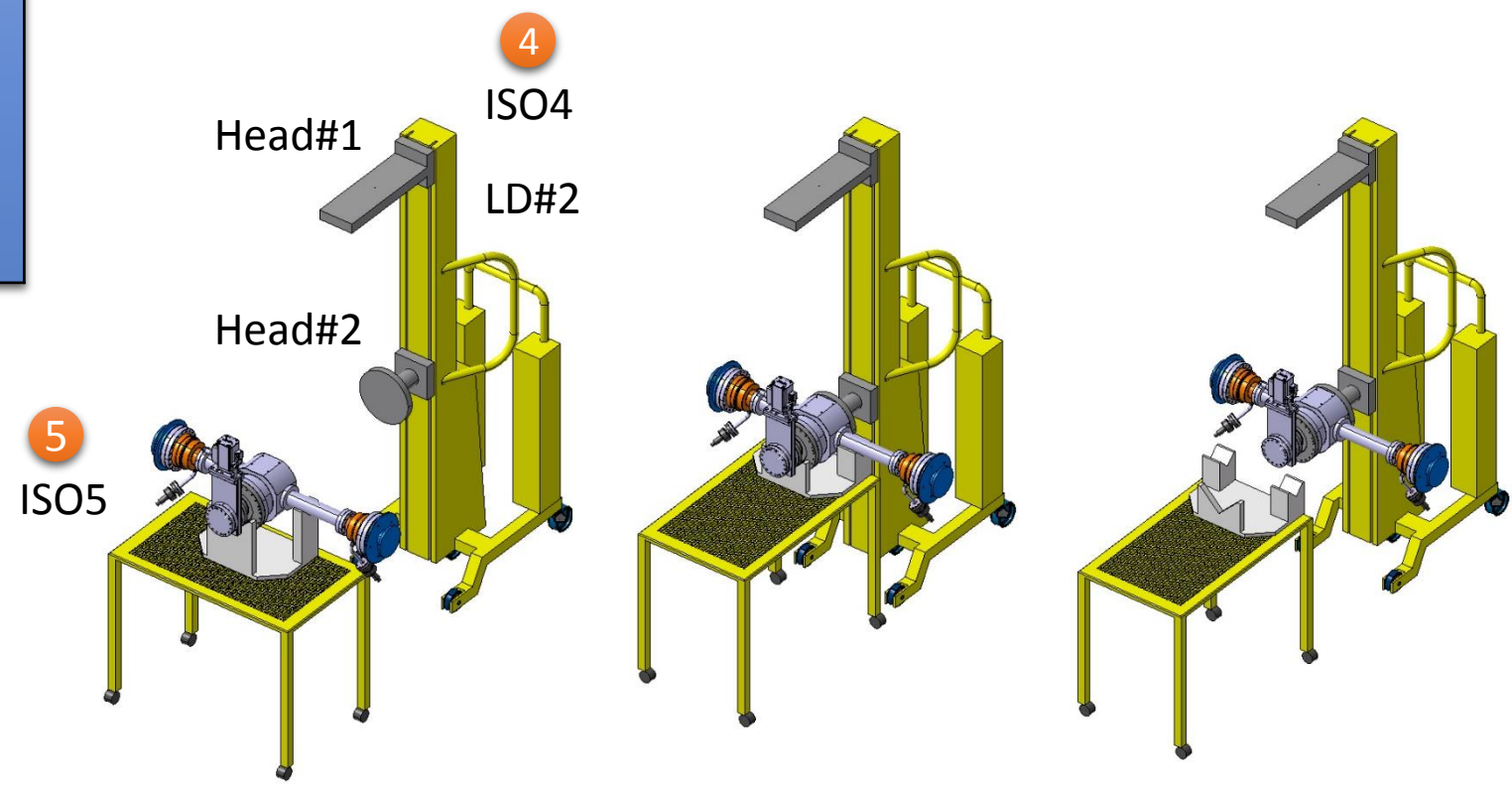
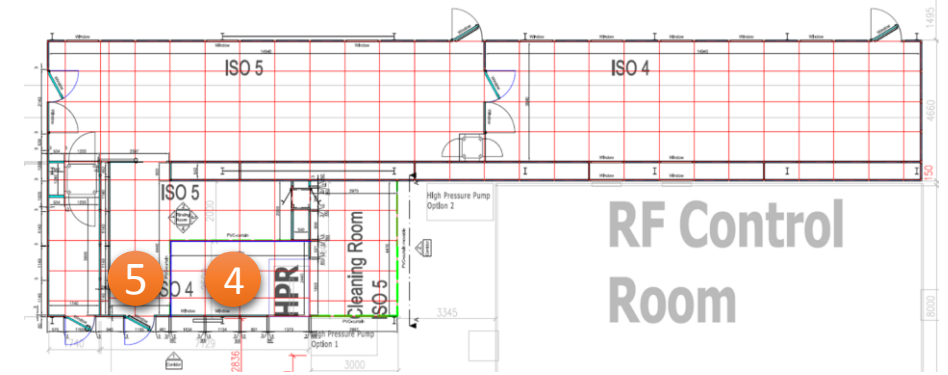
FPC assembly flowchart

Description	Area	Time
Transport in front of clean room ISO4	5	Day3
Remove the 2 nd layer of plastic bag	5	
Blow with pure air	5	



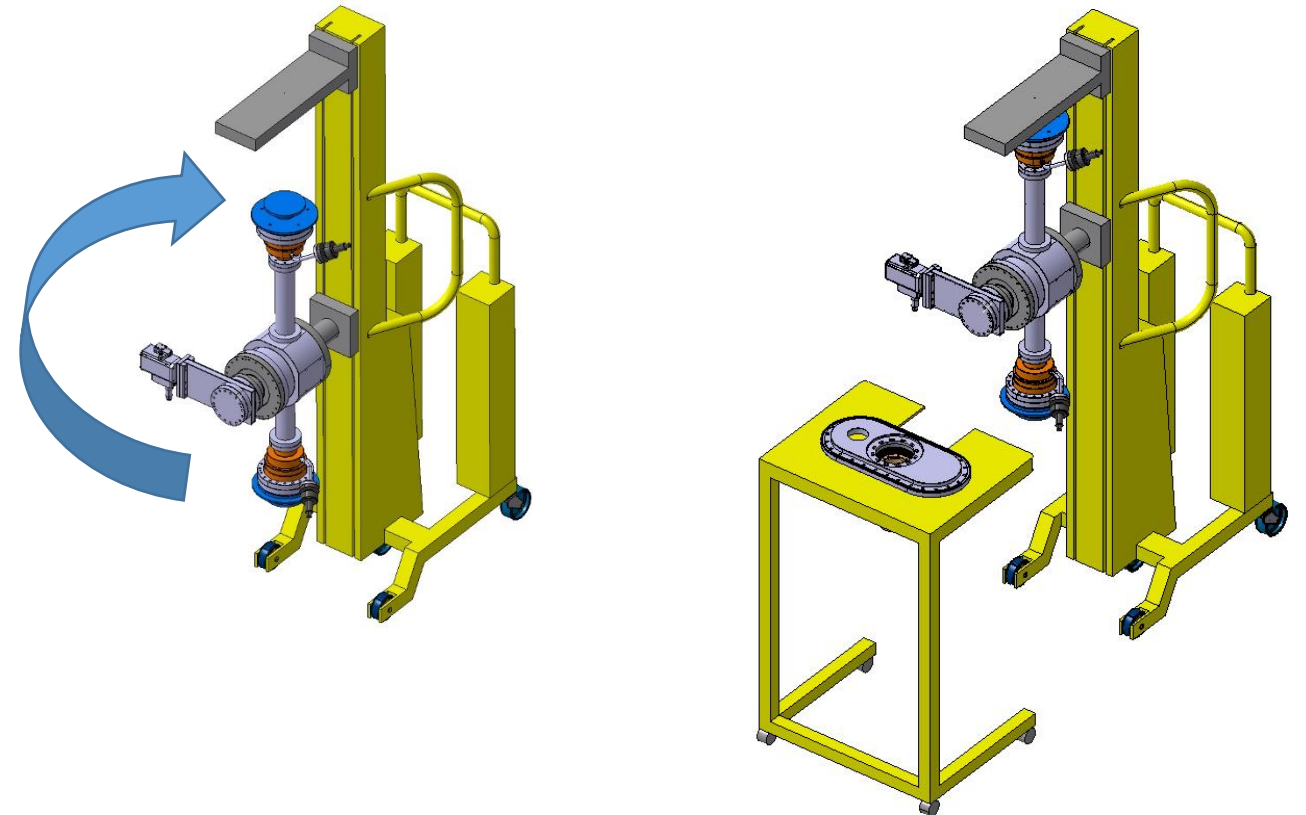
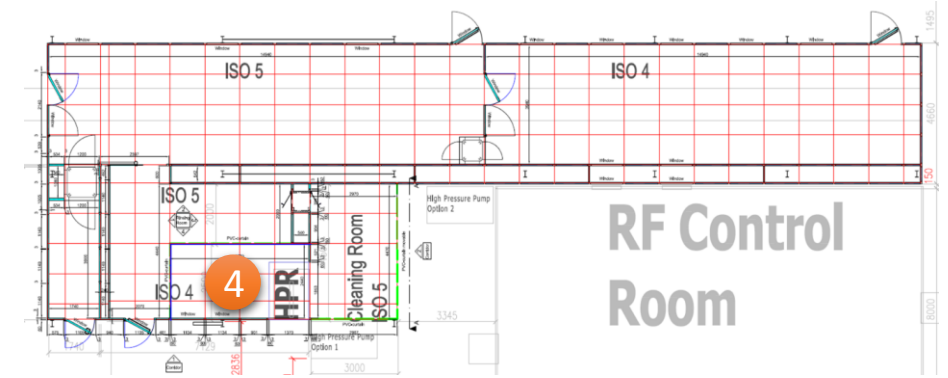
FPC assembly flowchart

Description	Area	Time
Move the Lifting Device#2 close to the test box & FPC	5	Day3
Connect on Head#2	5	
Move to ISO4	4	
Dry with pure air	4	

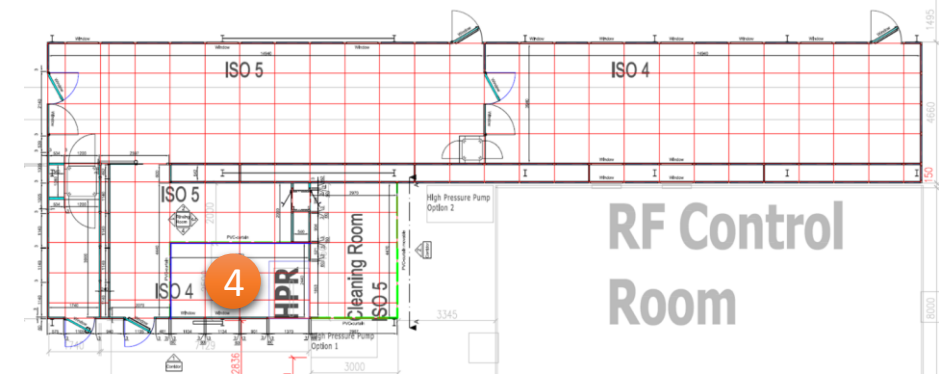


FPC assembly flowchart

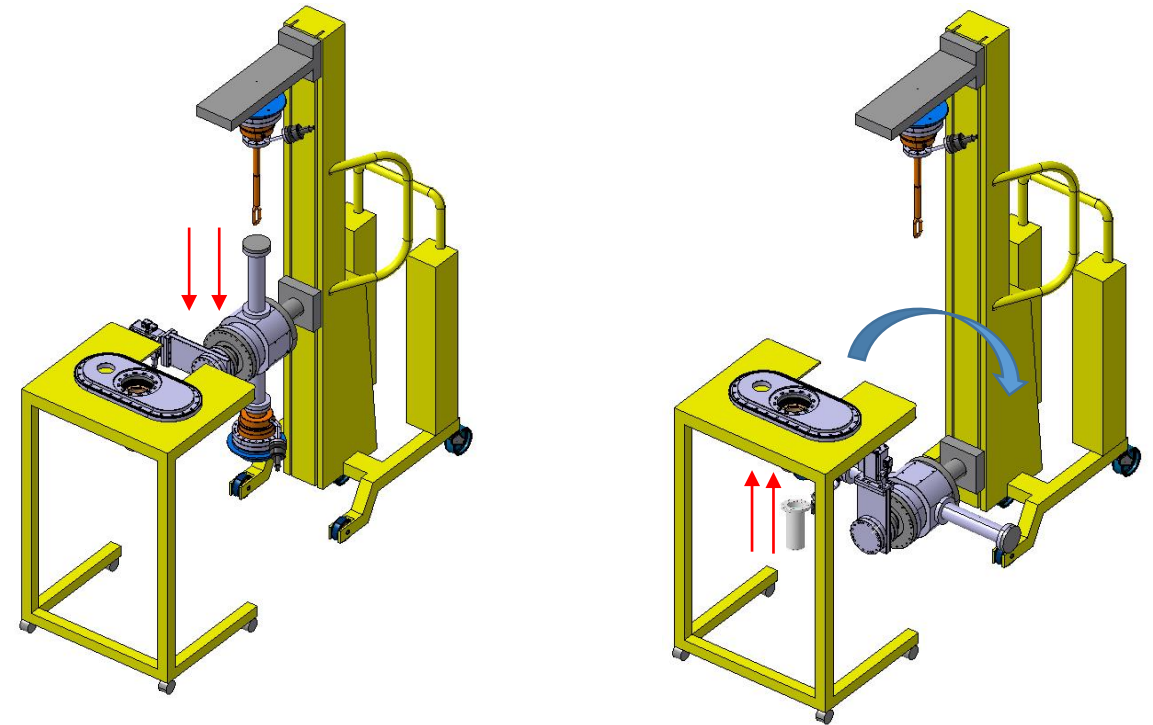
Description	Area	Time
Rotate vertically	4	Day3
Attach on Head#1	4	
Move S#1 close to the Lifting Device#2	4	



FPC assembly flowchart

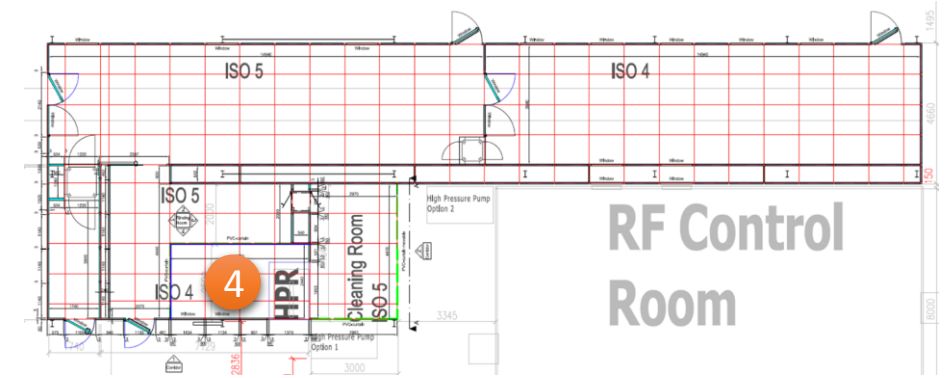


Description	Area	Time
Disconnect the 1 st coupler from the test box	4	Day3
Move down test box with Lifting Device#2	4	
Mount a blank flange on test box	4	
Mount the protection cover on Outer Line flange from bottom	4	
Rotate horizontally the test box with second FPC	4	

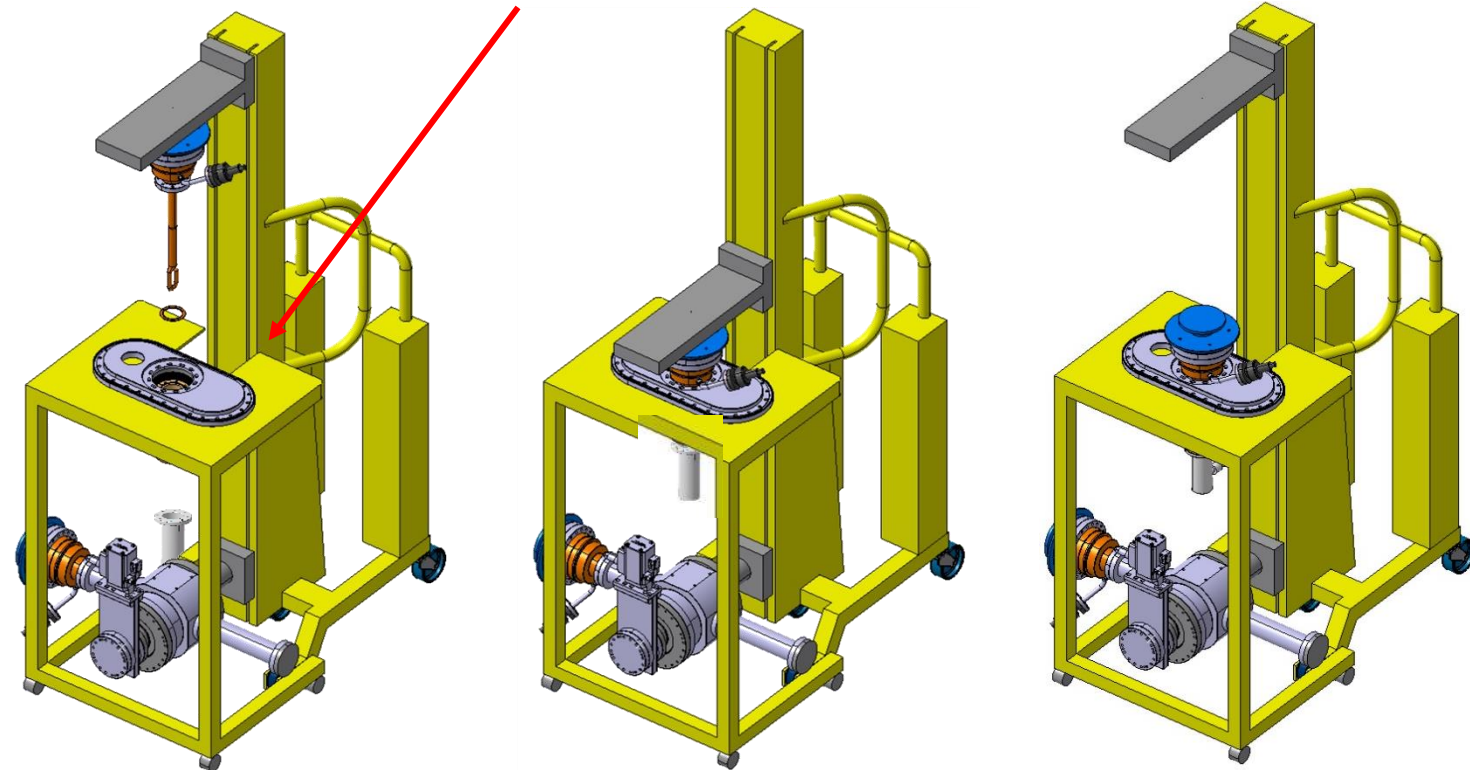


FPC assembly flowchart

Description	Area	Time
Fix S#1 to LD#2 (pre-aligned)	4	Day3
Place the seal on DWP flange	4	
Move down Head#1 (reason for having the protection cover first to avoid touching the antenna whilst moving down)	4	
Adjust the position with specific tool for adjustment (see next slide)	4	
Tighten until no gap between flanges, cross and circle	4	



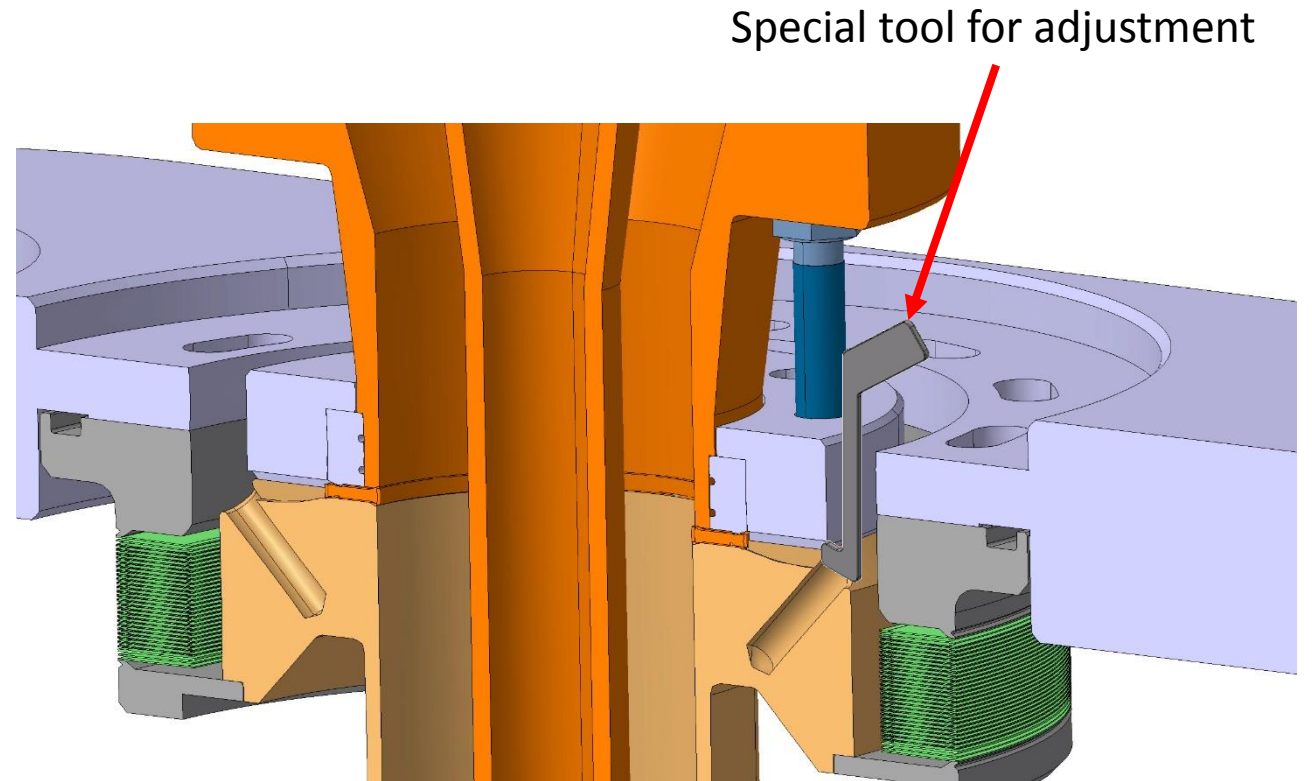
fixing system planned by BE/RF/SRF between S#1 and LD#2 for a good concentricity during assembly



FPC assembly flowchart



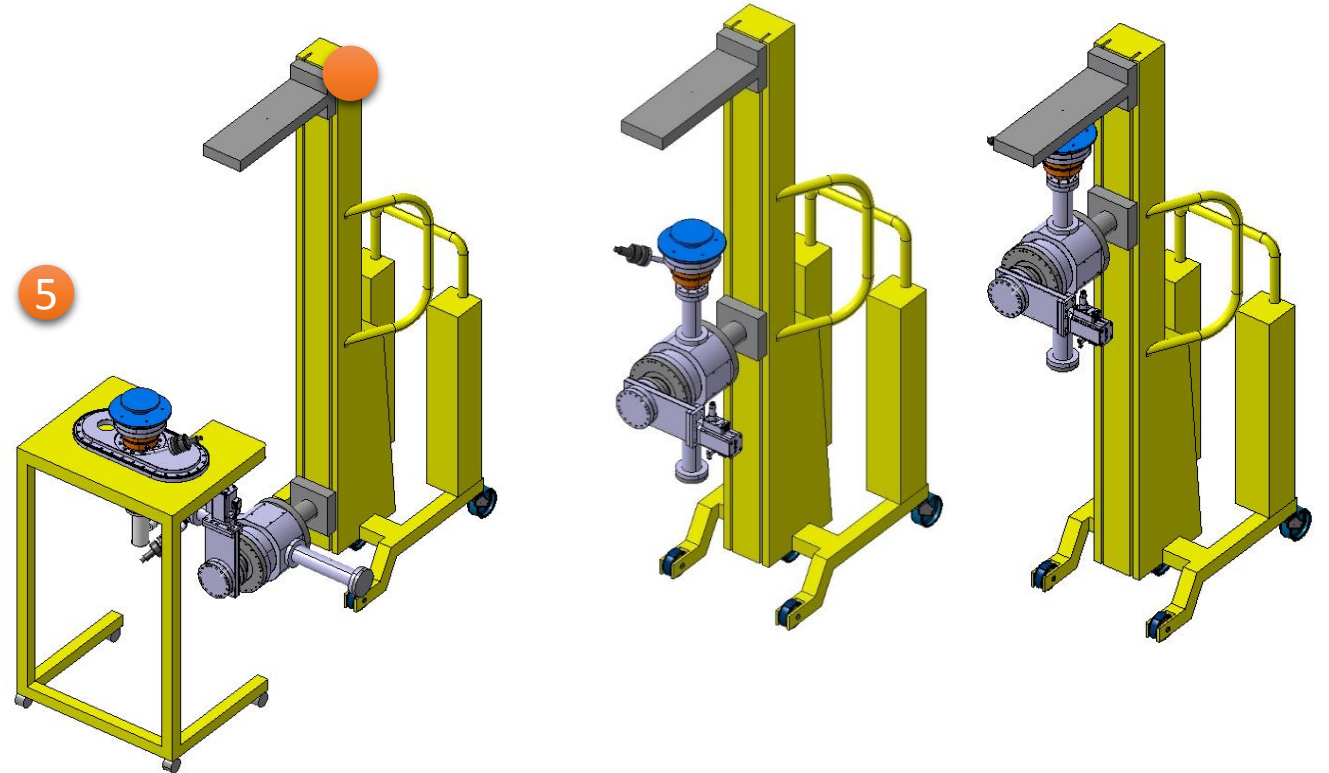
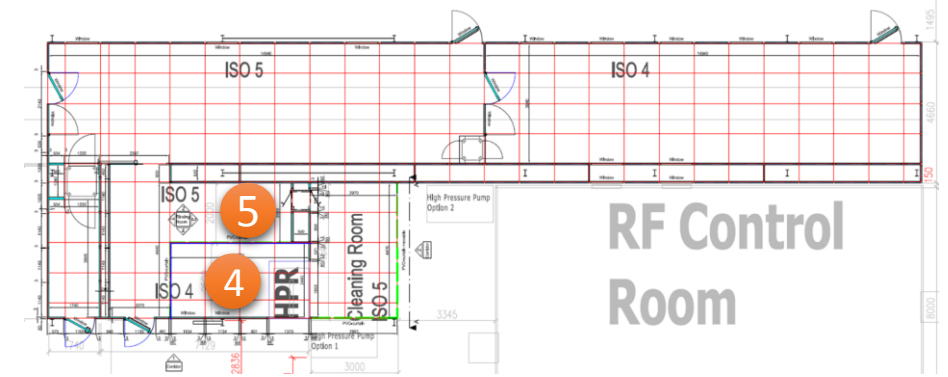
Enough clearance for screwing (rather than stud)
Main advantage : no friction whilst moving down the FPC, so no particles inside the FPC



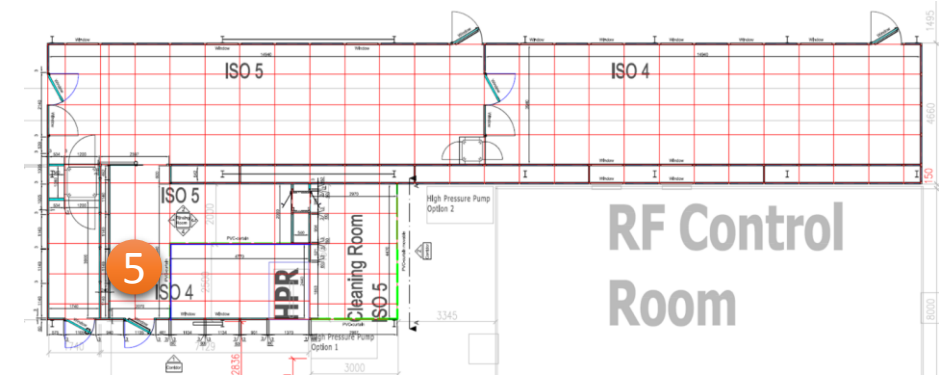
FPC assembly flowchart

Description	Area	Time
Store the FPC#1 in ISO 5	5	Day3

Description	Area	Time
Rotate the test box	4	Day3
connect the protection cover on Head#1 of LD#2	4	
Repeat the same process with FPC#2	4	
Store the FPC#2 in ISO 5	5	



FPC assembly flowchart

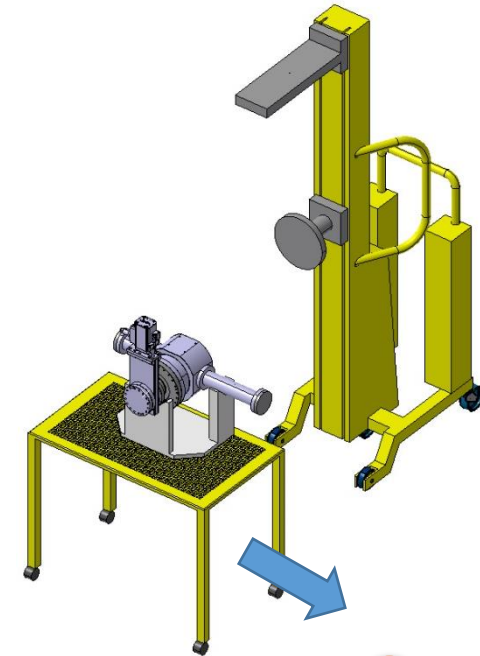
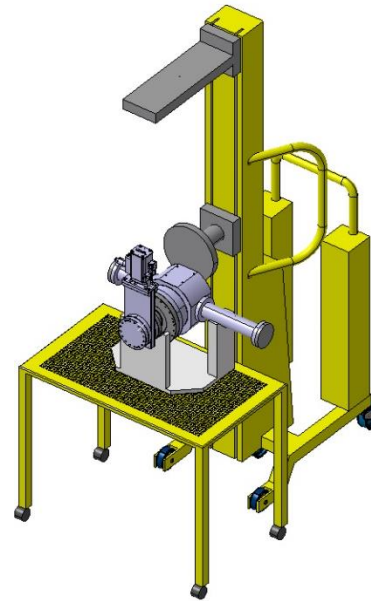
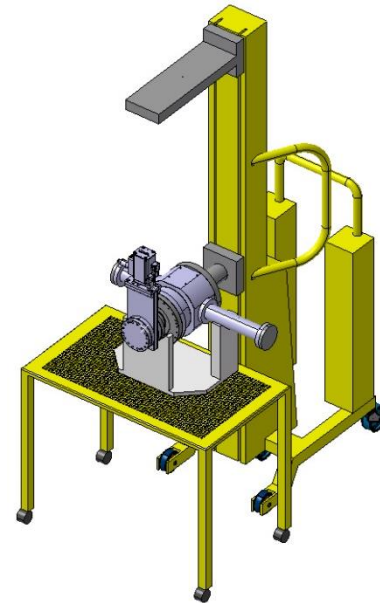
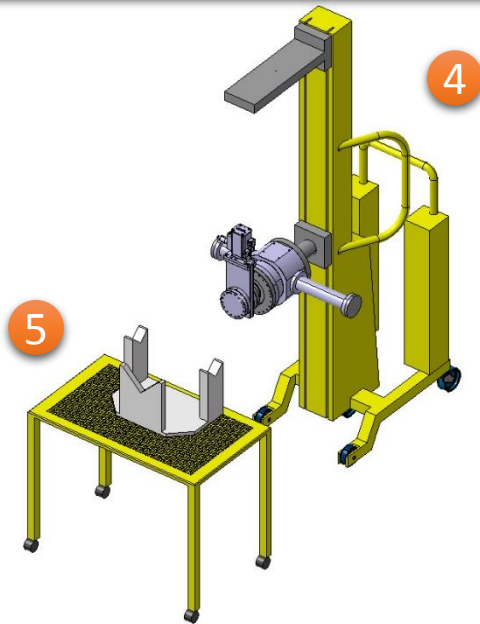
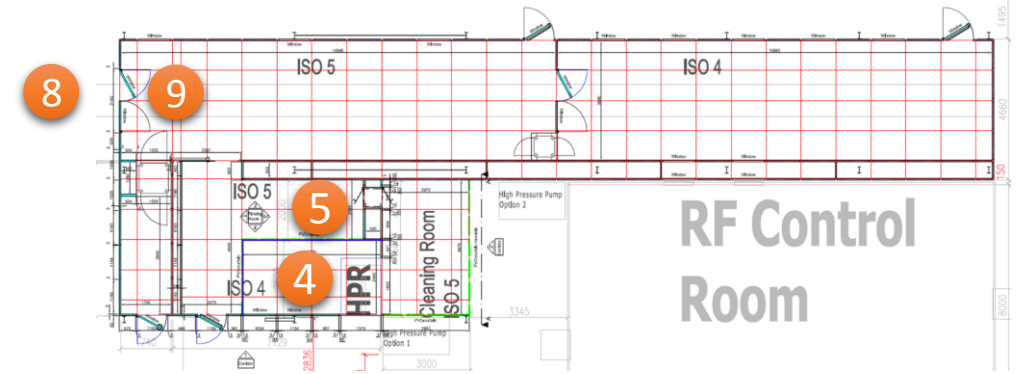


Description	Area	Time
Move FPC#1 close to vacuum detector	5	Day4
Leak detection to verify a leak rate $< 1 \times 10^{-10}$ mbar l/s		
Move FPC#2 close to vacuum detector		
Leak detection to verify a leak rate $< 1 \times 10^{-10}$ mbar l/s		



FPC assembly flowchart

Description	Area	Time
Disconnect the test box	4/5	Day4
pack the test box with 2 layers of plastic bags	5	
Move to ISO5	9	
Move outside	8	



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sebastien.calvo@cern.ch

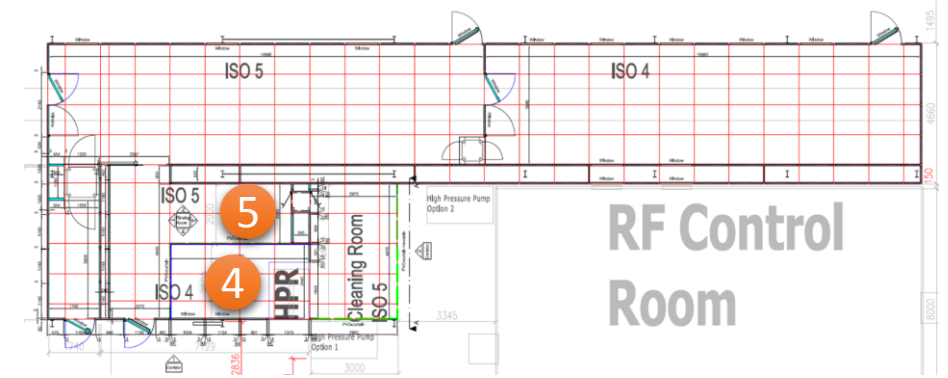
Review of clean room procedures for the HL-LHC Crab Cavity Program, FPC, 12-13 October 2016, CERN, Geneva, Switzerland



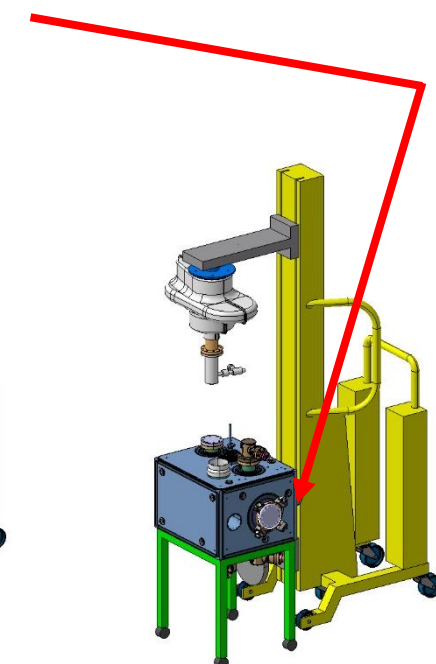
Assembly of FPC on cavity

FPC assembly flowchart

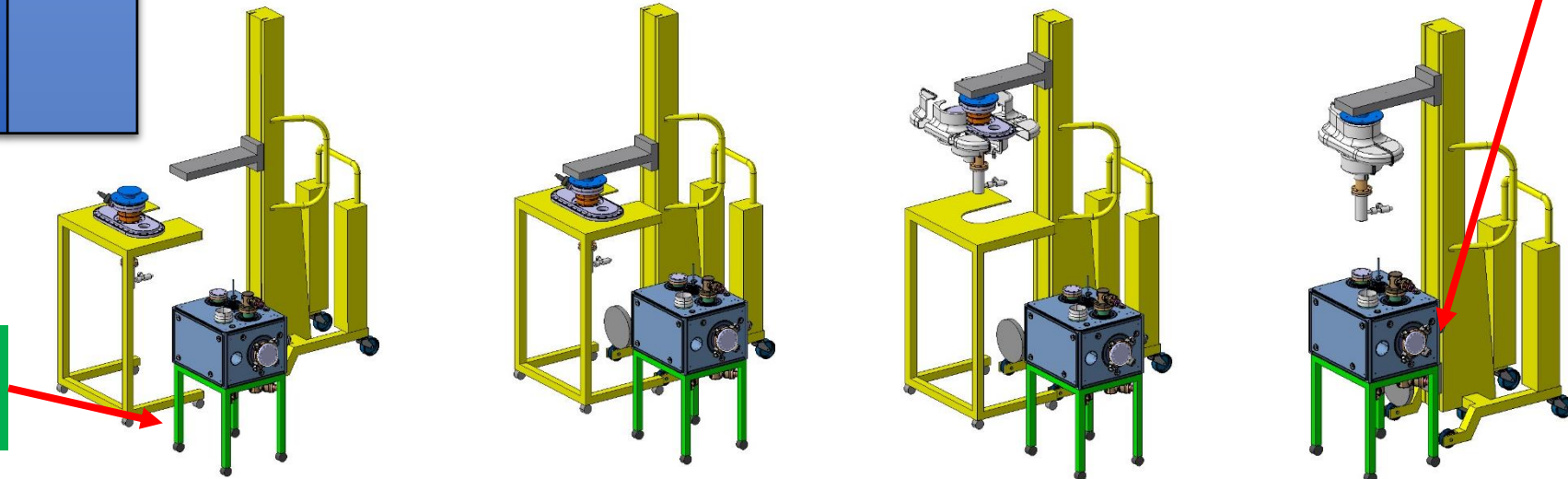
Description	Area	time
Move FPC to ISO4	5/4	Day1
Connect FPC to LD#2	4	
Move up the FPC		
Install the protection cover all around the FPC (see next slide)		
Fix cavity support#5 to LD#2 (pre-aligned)		



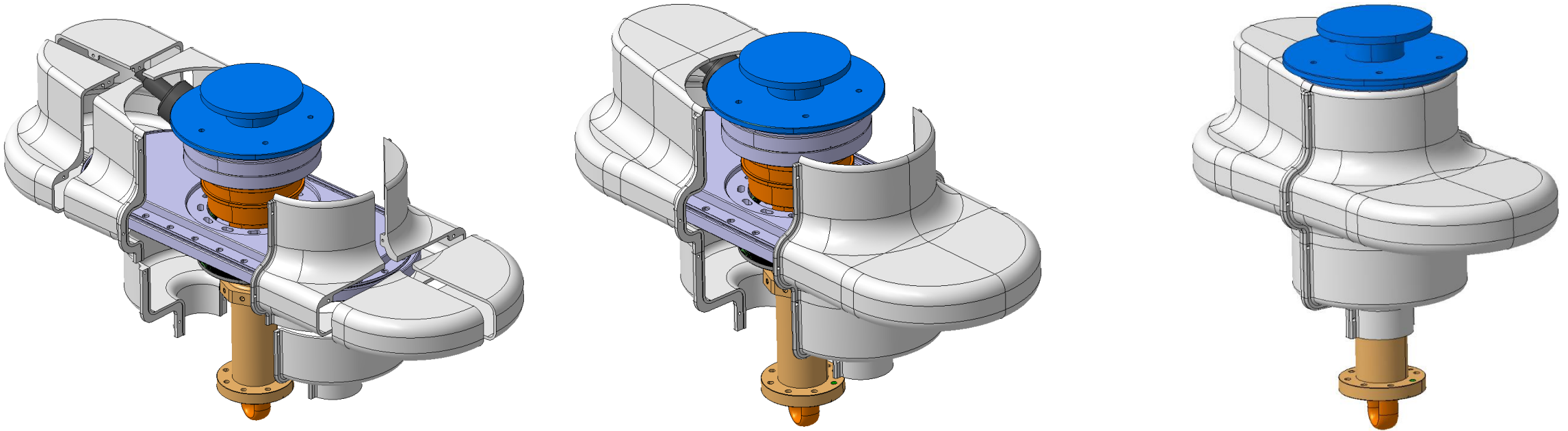
fixing system (under design) planned by BE/RF/SRF between S1 and L2 For a good concentricity during assembly



The support of the cavity will be provided by EN-MME



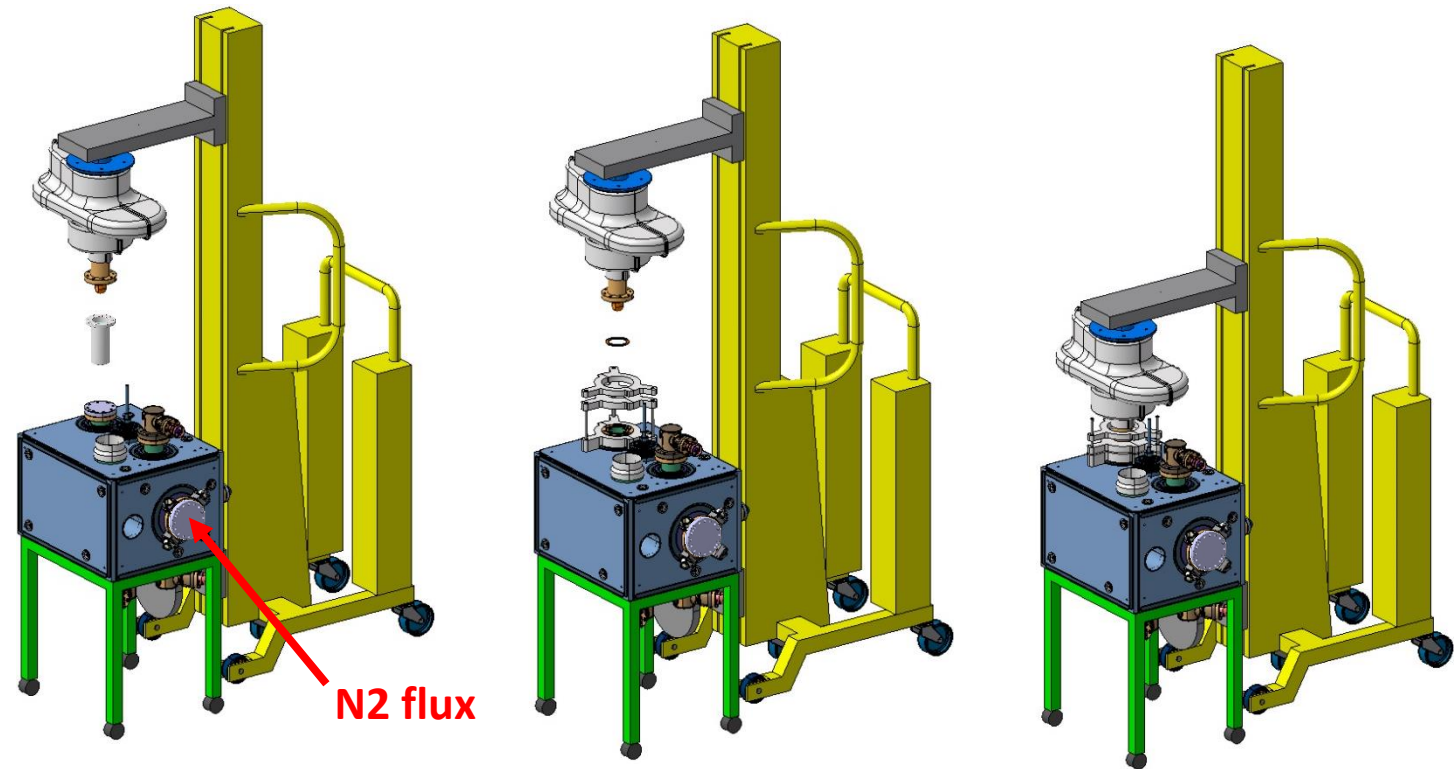
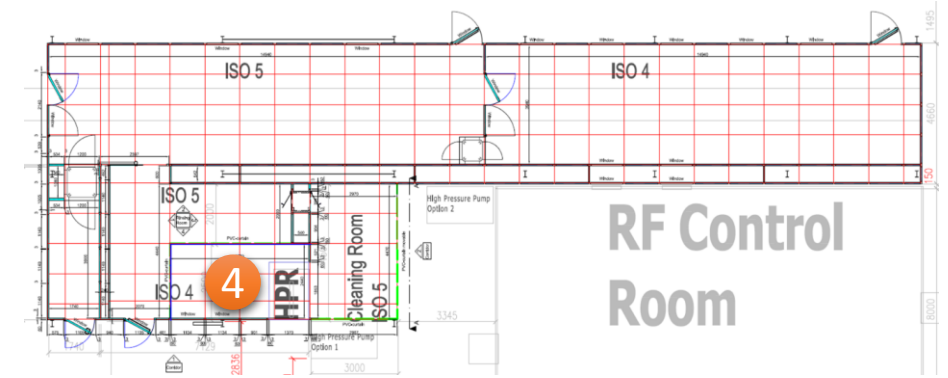
Protection cover around the FPC



To prevent any particles from the complex shape of the coupler to fall down into the cavity

FPC assembly flowchart

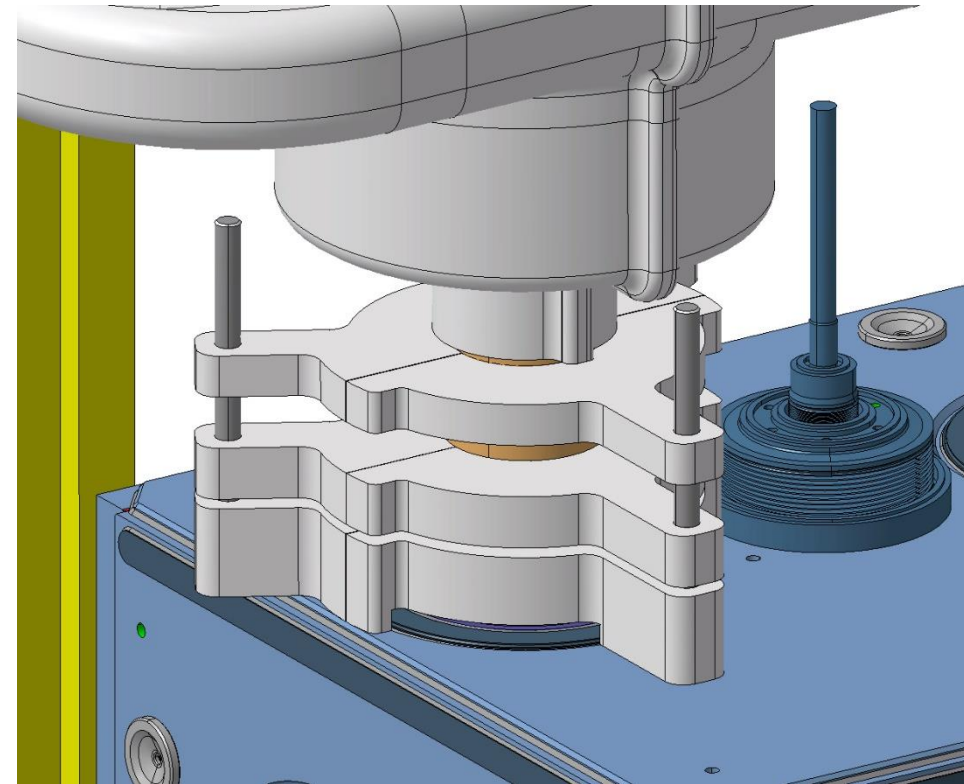
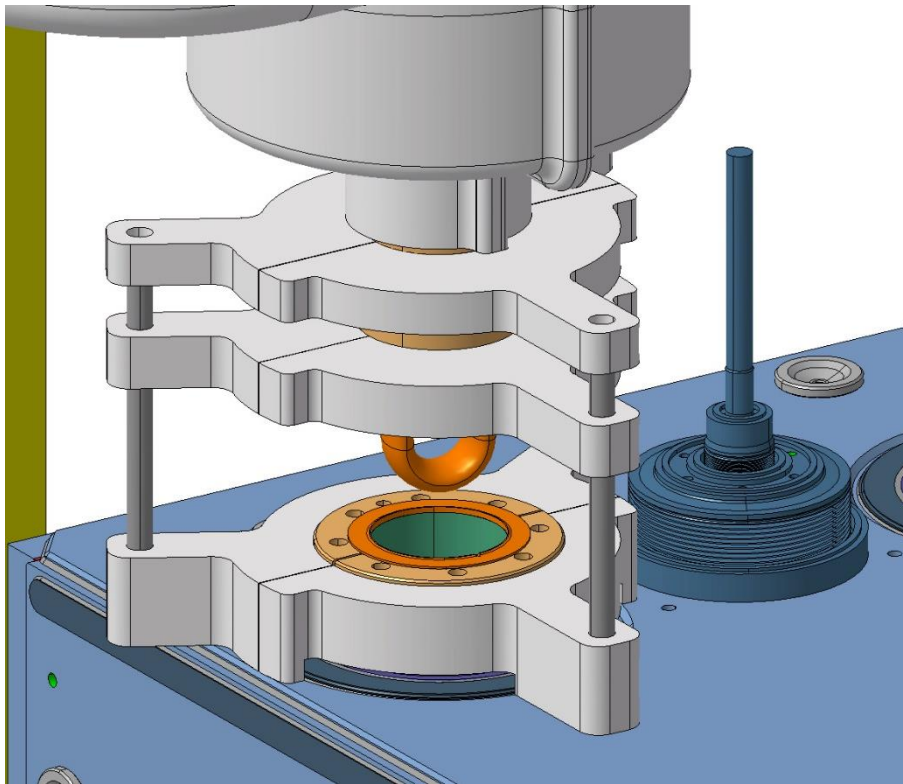
Description	Area	Time
Insert ISO4 filtered Nitrogen (N2) in the cavity ATM + 0.2bars with a pressure reducer and an output flow through the FPC port of around 20 l/min	4	Day1
Remove the screws of the FPC port (keeping the flange in place)		
Remove protection of DWP		
Mount the fine guiding system		
Remove the flange of the FPC port		
Place copper seal on FPC port		
Move down FPC		



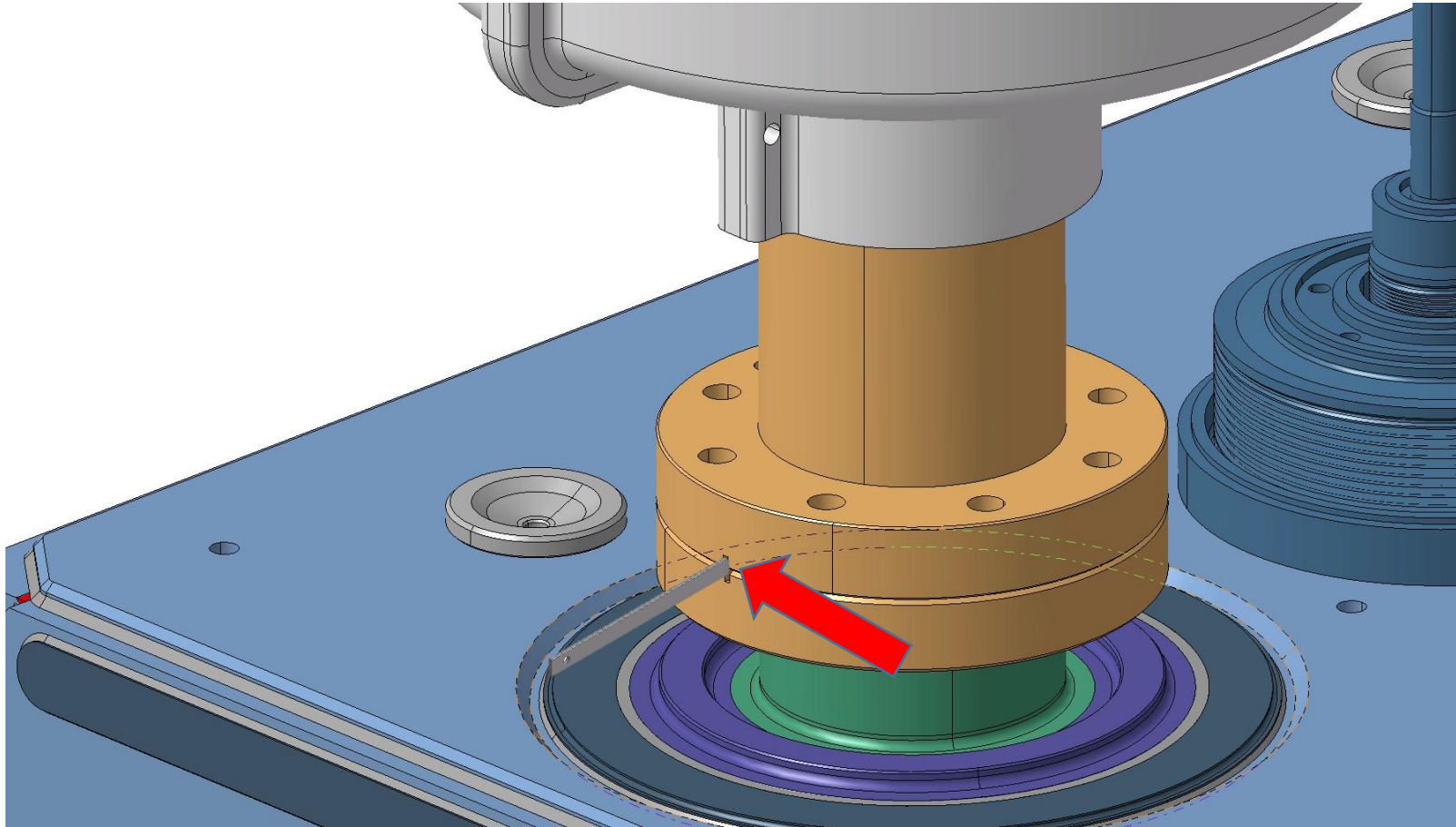
Mounting tool and prepositioning system (axially and angularly)

Under design

Accura 25 qualified (Mathieu) + Stainless Steel
Sliding parts as far as possible form the aperture
System still to be tested and qualified

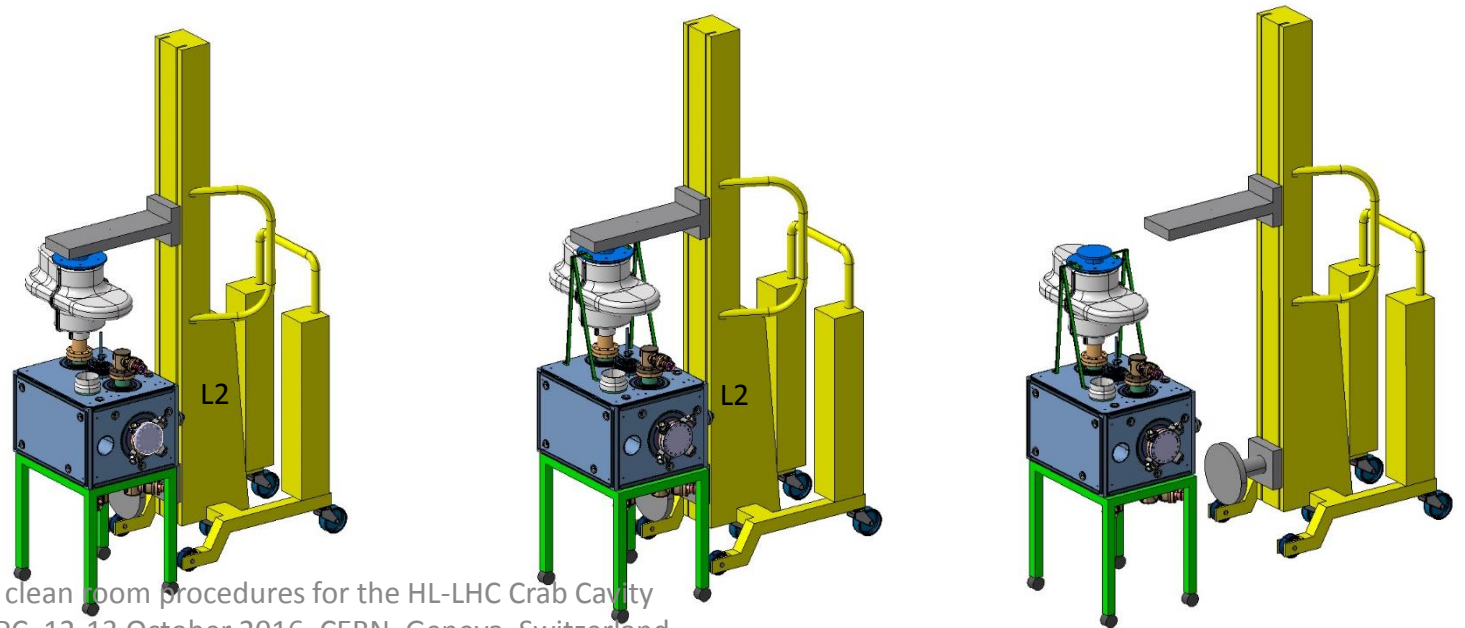
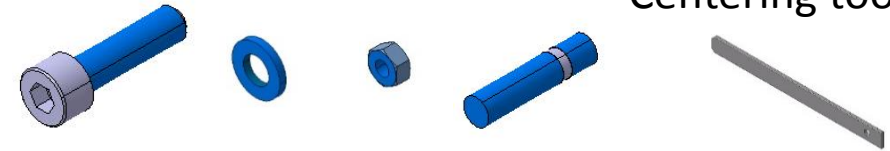
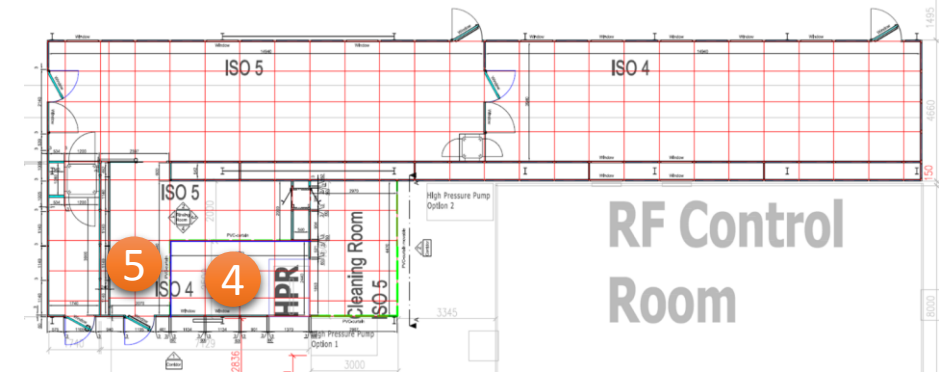


Angle positioning system

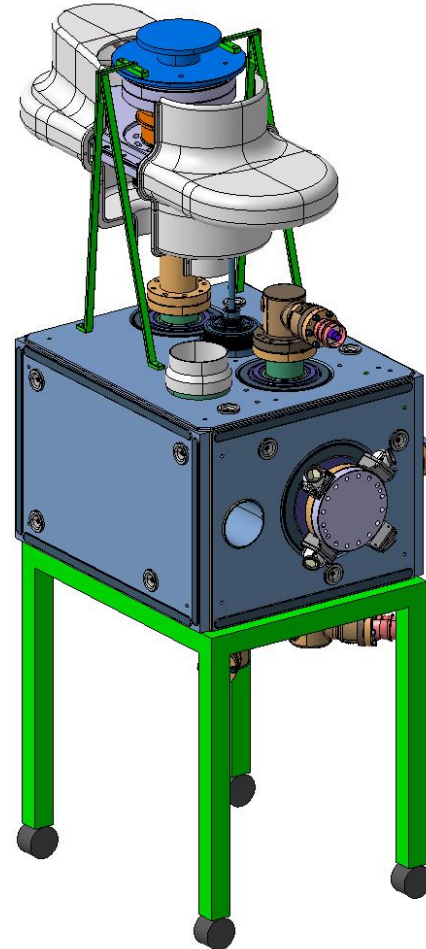
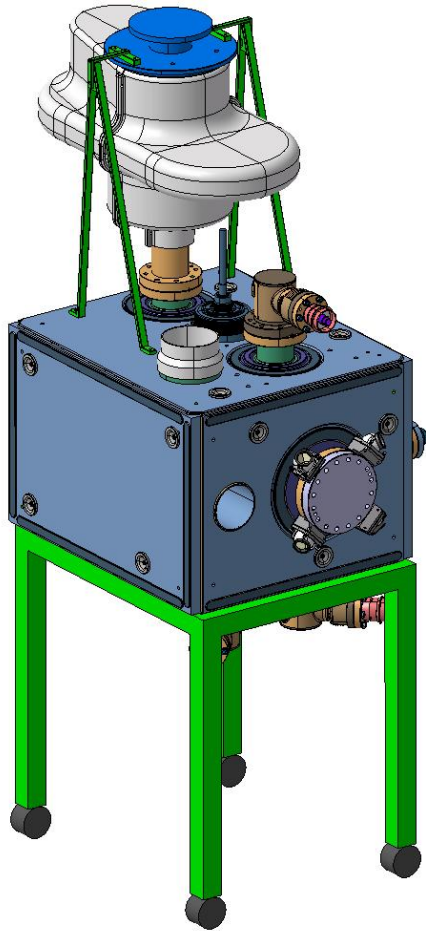


FPC assembly flowchart

Description	Area	time
Remove the positioning system	4	Day1
Mount washers and screws	4	
Tighten until no gap between flanges, cross and circle, whilst stopping Argon pressure in cavity	4	
Add stiffeners	4	
Remove LD#2	4	
Leak detection to verify a leak rate $< 1 \times 10^{-10}$ mbar l/s	5	



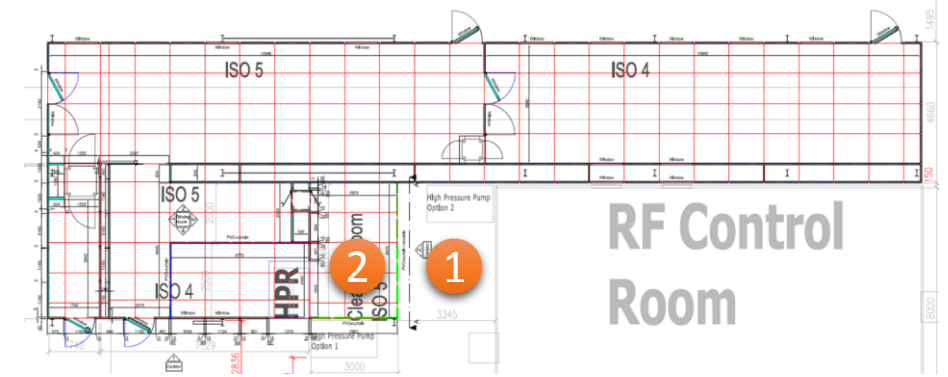
Stiffening system



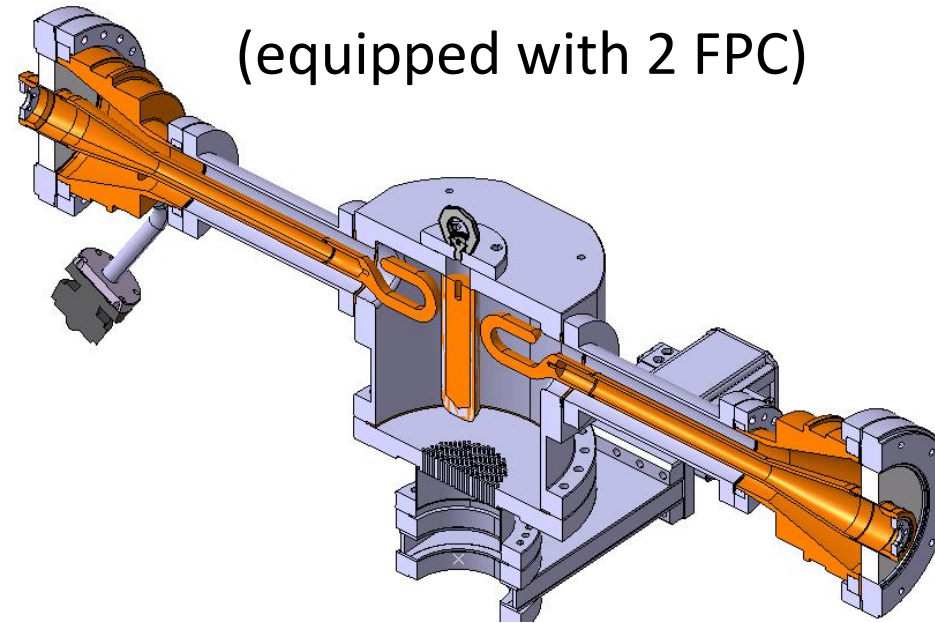
FPC on test box

Description	Area	Time
Delivery of FPC & Test Box packed by the Chemists experts in plastic bag	1	Day1
Blow with pure air	1	
Go to clean room ISO 5	2	
Blow with pure air and open the plastic bag	2	
Dry with pure air	2	
Keep under laminar flux	2	Night 1

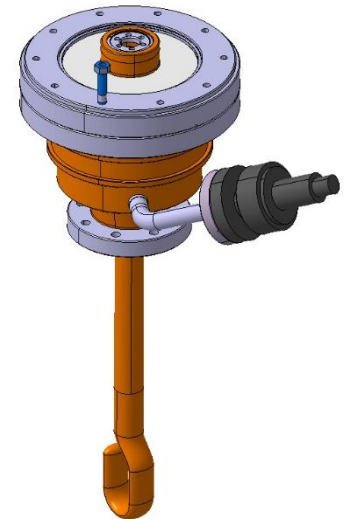
Same way as with the previous processes except that we will not have the Lifting Device available yet



Test Box
(equipped with 2 FPC)



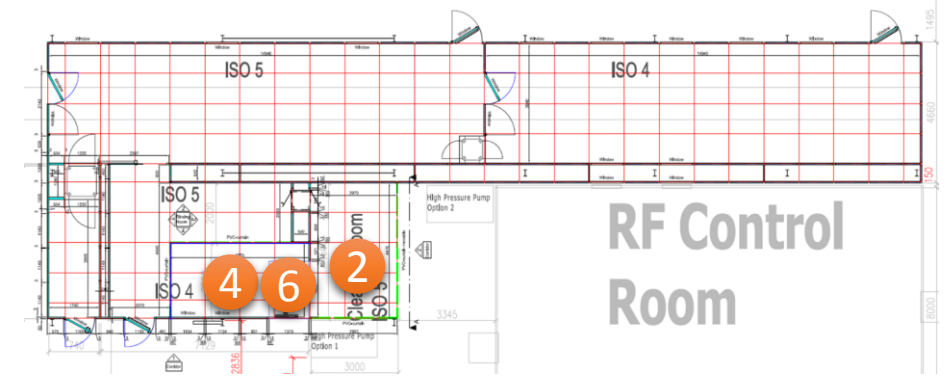
FPC



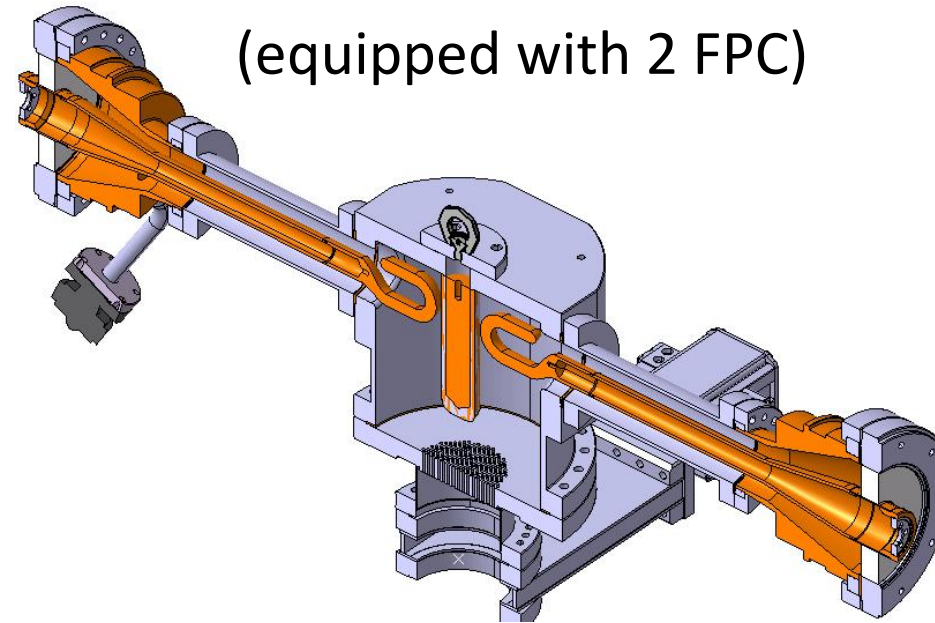
FPC on test box

Description	Area	Time
Blow and particles counting	2	Day2
Go to HPR	6	
Keep under laminar flux	6	Night 2
Move FPC, Test Box and Tools in ISO4 area	4	Day3

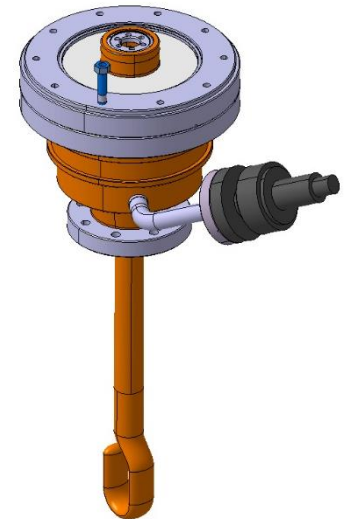
Same way as with the previous processes except that we will not have the Lifting Device available yet



Test Box
(equipped with 2 FPC)

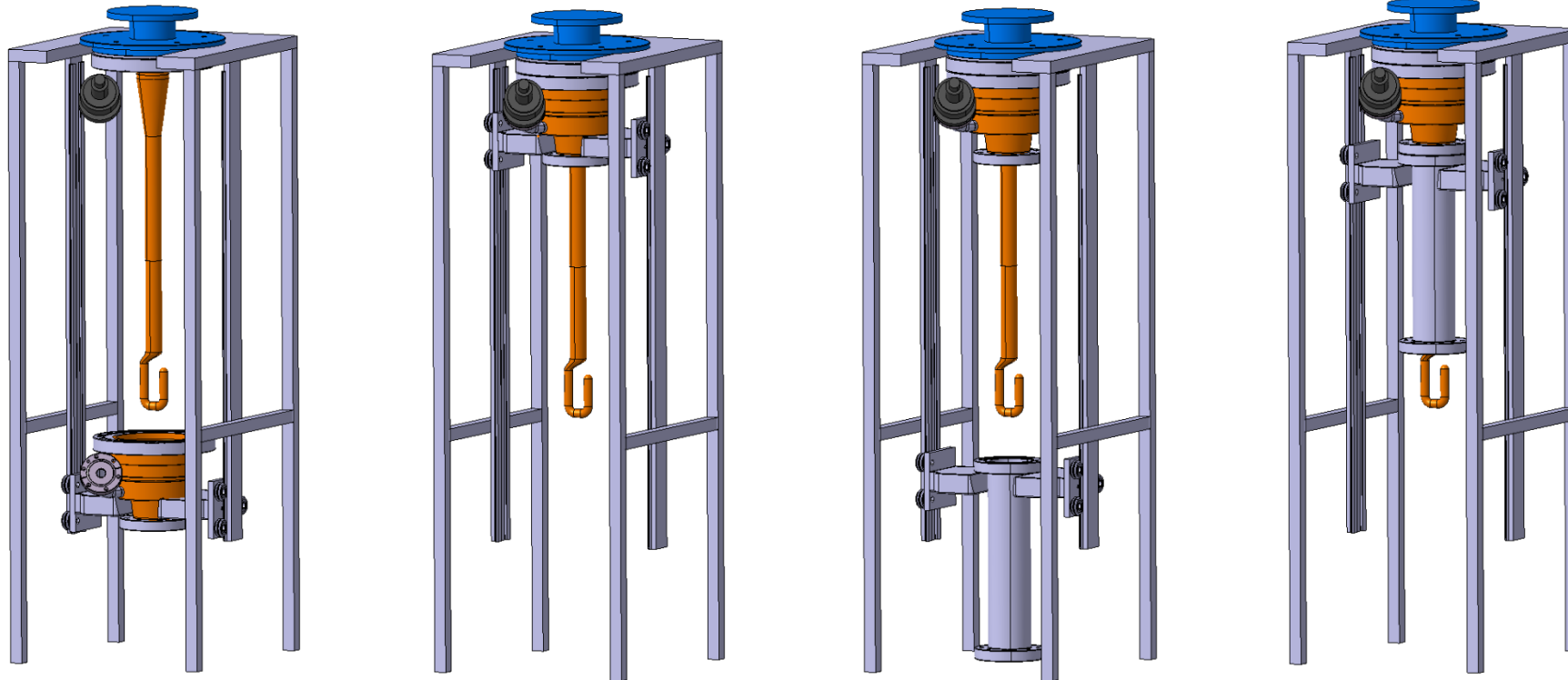
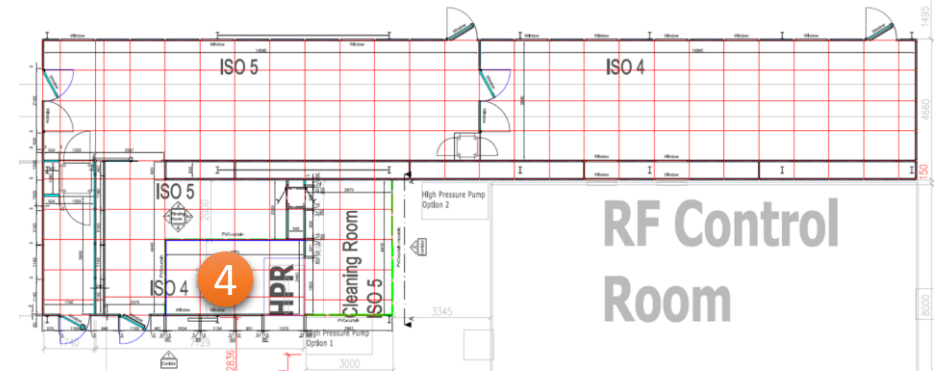


FPC



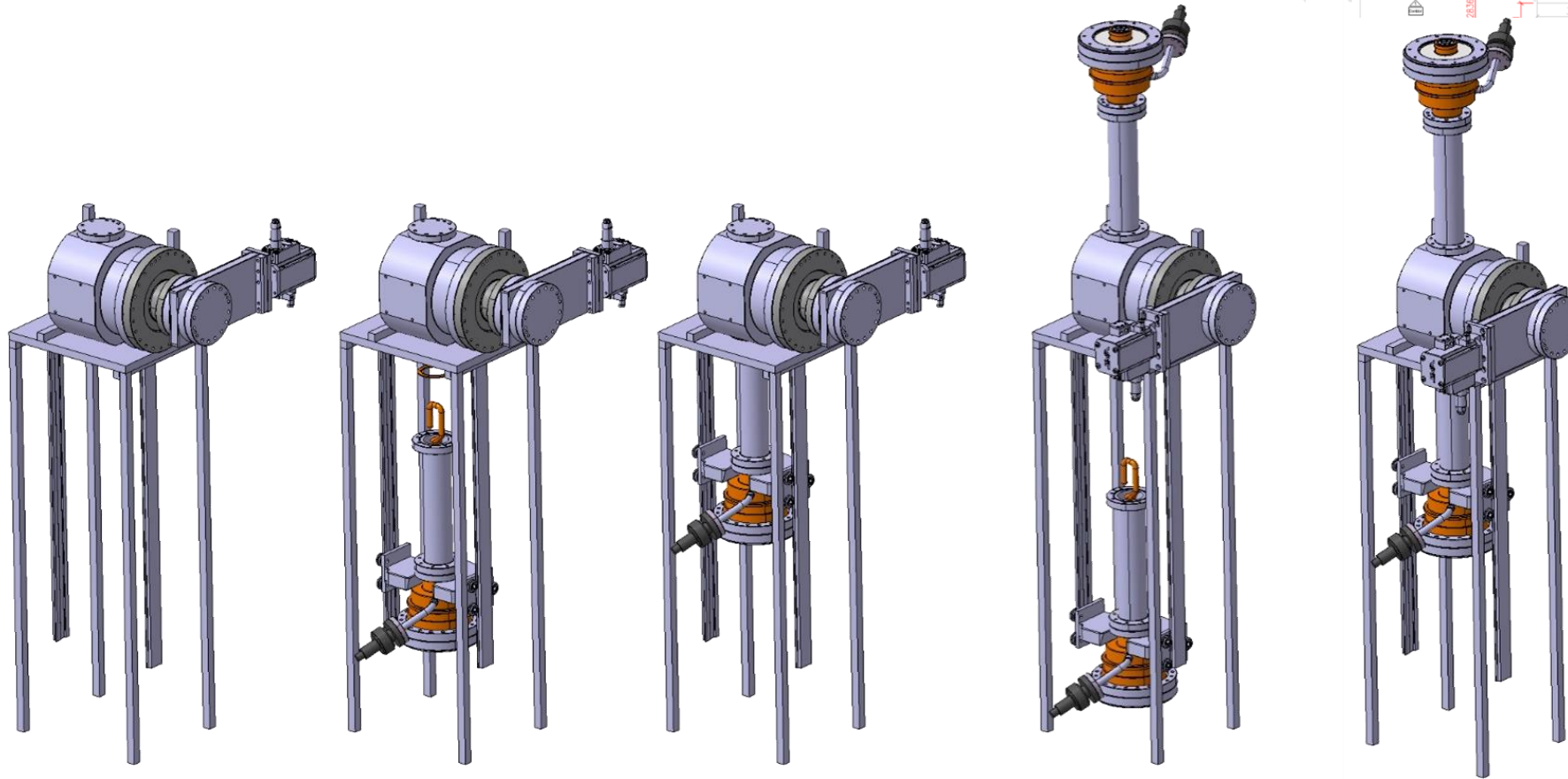
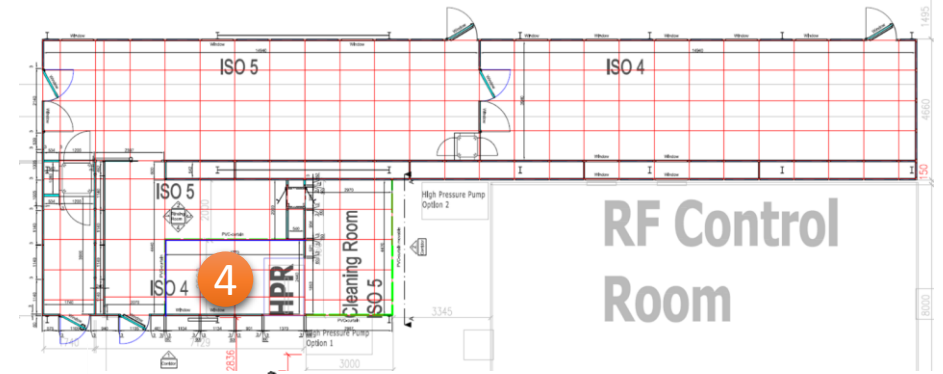
FPC on test box

x2



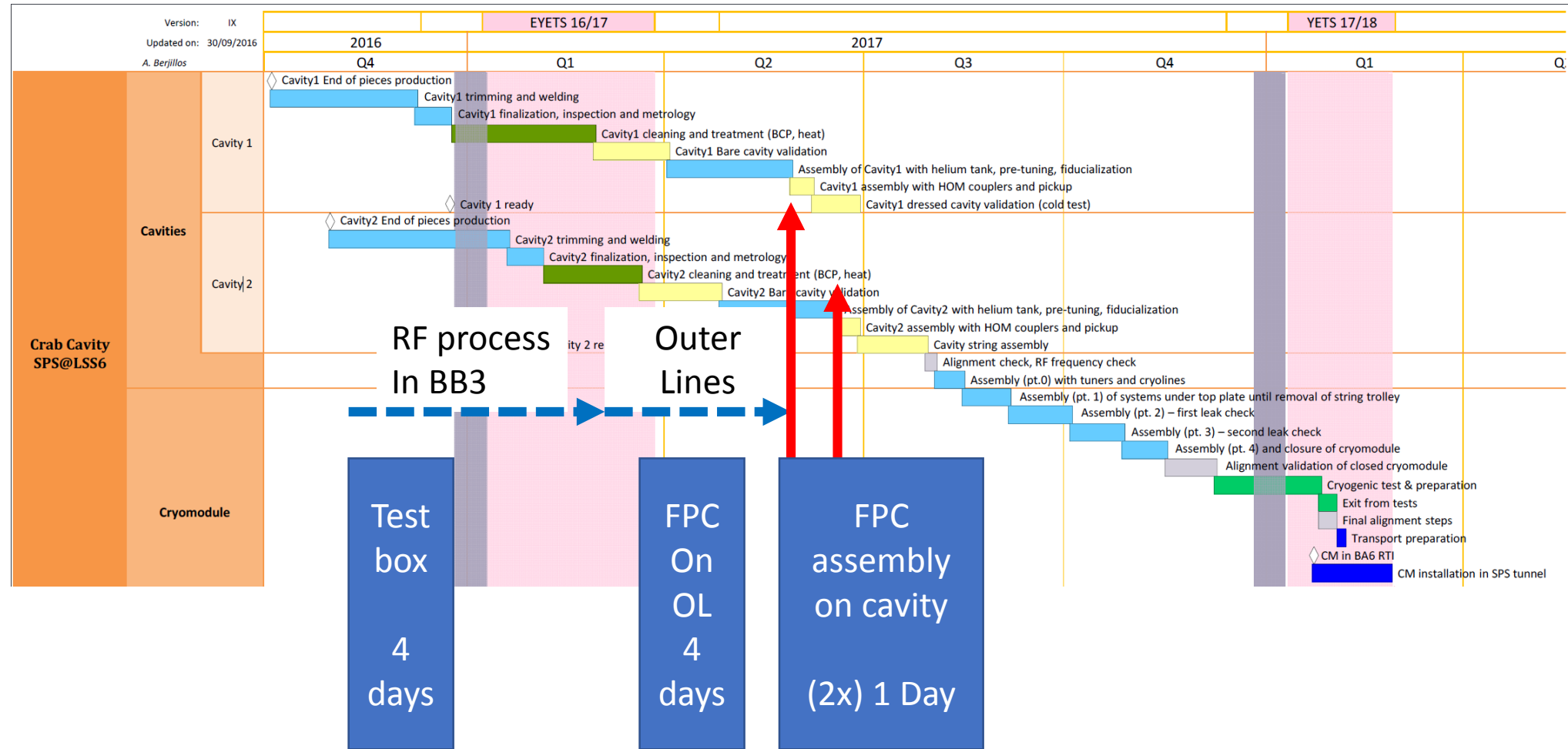
All tools under study
will be made for ISO4
clean room

FPC on test box



All tools under study
will be made for ISO4
clean room

Planning



ANNEXES

Total mounting tolerances

After mounting tolerances

Off-center tolerances DN150 = mini -0.05mm maxi 0.30mm

- Seal tolerance DN150 : $\varnothing 171.3 \rightarrow \pm 0.05$
- Flange tolerance DN150 : $\varnothing 171.4 \rightarrow 0.1/0$ (x2)

Off-center tolerances DN63 = mini -0.1mm maxi 0.5mm

- Seal tolerance DN63 : $\varnothing 82.4 \rightarrow \pm 0.05$ (x2)
- Flange tolerance DN63 : $\varnothing 82.5 \rightarrow 0.1/0$ (x4)

Total angles tolerances mini -0.45mm maxi 0.3mm $\rightarrow +0.3^\circ/-0.45^\circ$

- Ungasing slot tolerance : $1.5 \rightarrow \pm 0.1$ (x3)
- Angle positioning tool tolerance : $1.4 \rightarrow 0/-0.05$

Asked positioning for FPC assembly:

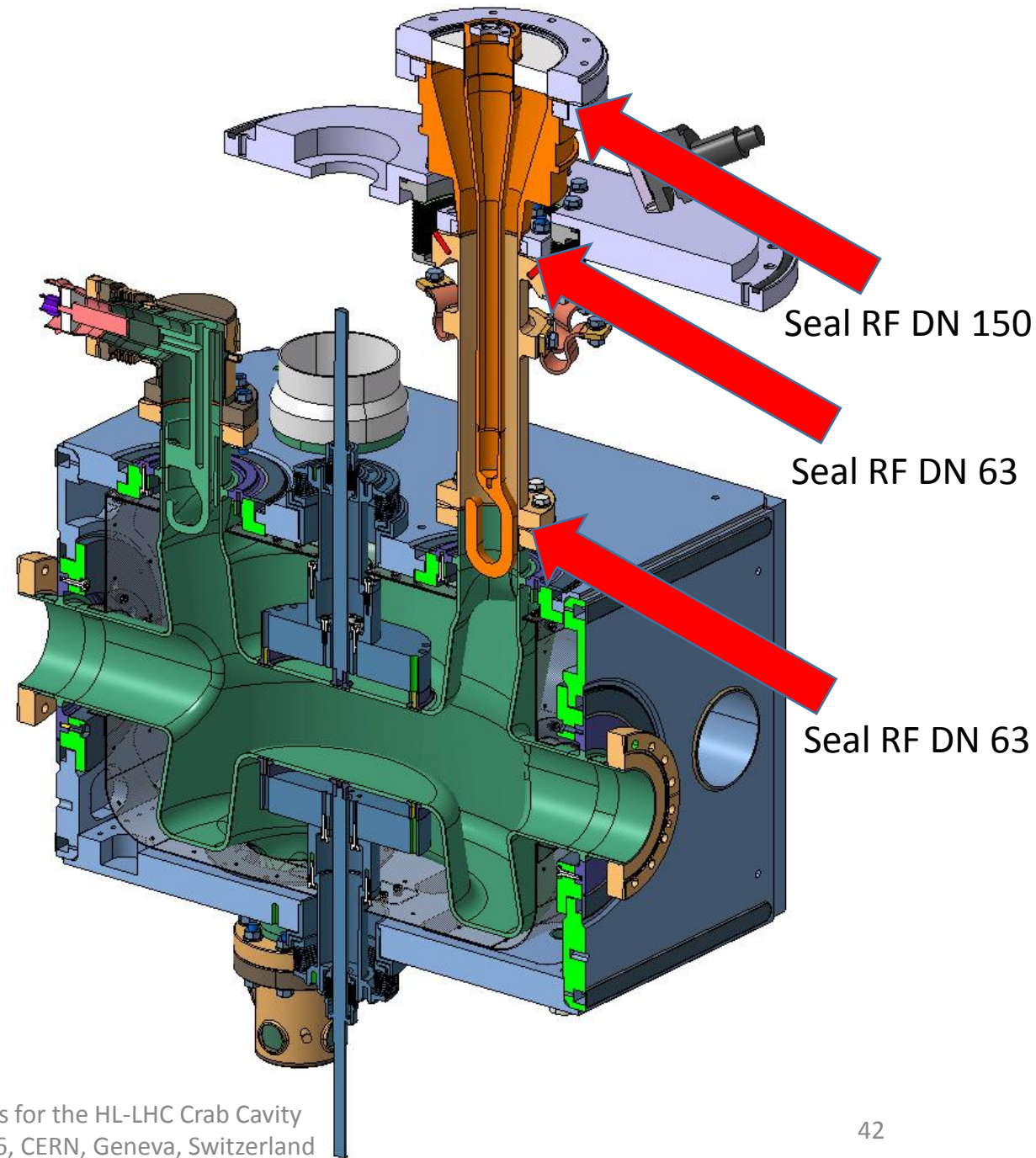
Axials tolerances ± 1 mm

Angles tolerances $\pm 1^\circ$

what we can have with the accumulated tolerances max:

Axials tolerances $+0.8$ mm/ -0.15 mm

Angles tolerances $+0.3^\circ/-0.45^\circ$



Particule counting Accura 25 3D printing

Test place: SM18

Cleanroom: Softwall clean room ISO 5

Particle counter: SOLAIR 3200

Operator: S. Benvenuti, C. Duval, M. Therasse

Sample: Accura 25

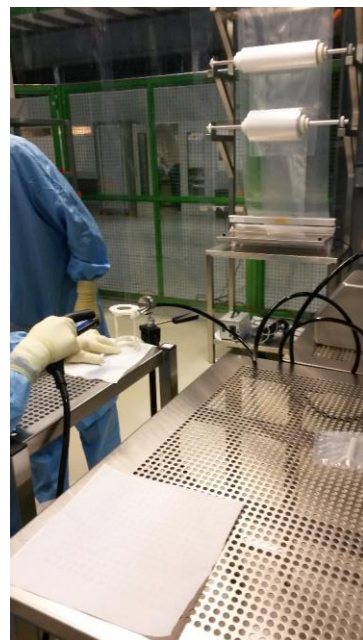
Setup:

Sample degreased with standard process (bldg. 102).

Sample cleaned with dust tissue with alcohol, and blew with filtered N2 gas.

Calibration of the particle counter with a calibrated filter.

The sample is blown in different positions with filtered N2 gas (ionizing air gun) in front of the particle counter.



Sample Test table:

Timestamp	Sample Time(s)	Volume(L)	0.3	0.5	1	3	5	10	Alarm
20/09/2016 12:20	60	56.6	302	190	150	54	21	10	None

eric.montesinos@cern.ch
sebastien.calvo@cern.ch

20/09/2016 14:55	60	56.6	2	0	0	0	0	0	None
20/09/2016 14:57	60	56.6	404	312	228	63	24	15	None
20/09/2016 14:58	60	56.6	263	211	160	60	25	13	None
20/09/2016 15:00	60	56.6	563	370	254	74	28	12	None
20/09/2016 15:01	60	56.6	800	498	295	91	36	15	Yes
20/09/2016 15:02	60	56.6	14	9	4	0	0	0	None
20/09/2016 15:03	60	56.6	53	23	14	2	1	0	None
20/09/2016 15:04	60	56.6	76	50	40	18	14	11	None
20/09/2016 15:06	60	56.6	4	2	2	2	1	1	None
20/09/2016 15:08	60	56.6	129	88	59	17	5	1	None
20/09/2016 15:09	60	56.6	44	32	21	5	1	0	None
20/09/2016 15:10	60	56.6	69	49	31	13	6	3	None
20/09/2016 15:11	60	56.6	28	18	14	8	4	3	None
20/09/2016 15:12	60	56.6	64	21	7	0	0	0	None
20/09/2016 15:13	60	56.6	363	286	207	53	18	7	None

Results:

Sample compatible with ISO4.

Pay attention on the surface roughness. Probably due to the 3D printing process.

The surface and angles have to be machined to be smoother (For cleaning and manipulation).

Positioning system design on going
Accura 25 qualified (Mathieu) and Stainless Steel
Sliding parts as far as possible form the aperture
System still to be tested and qualified