1. PROJECT CODE	ALICE TASK SHEET		
ALICE			
2. EDMS ID. XXXX	3. TASK NO. CAGE_170331_016	4. PAGE 1 OF 34	
5. DISCREPANCY REPORT SHEET(S) NUMBER(S)			
6. CATEGORY INSTALLATION HDW	7. PART NAME CAGE BEAM PIPE	8. SERIAL NUMBER	
9. APPLICABLE DOCUMENTS			
10. TASK TITLE Cage and beampipe installation in ALICE for LS2 Upgrade			

11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PE
	SCOPE The purpose of the present document is to provide information and guidelines for the installation of the Cage and the beampipe during LS2, inside the ALICE TPC bore. **WARNING** **This procedure requires working in a radiation controlled area. All Safety regulation and procedures shall be followed.** **This procedure requires exposure of the beryllium beam pipe. Only authorized personnel shall be involved.** **Fence the Delphiframe around the working area to limit the access only to personnel involved in the intervention. Suspend any other activity in L3 and on the Delphiframe**	

14. ORIGINATOR	15. TASK PROJECT ENGINEER
Corrado Gargiulo	
16. ALICE PROJECT ENGINEER	17. QUALITY-SAFETY ENGINEER
Corrado Gargiulo	Elisa Laudi Klaus Barth
18. ALICE INTEGRATION	19. ALICE TECHNICAL COORDINATOR
	Arturo Tauro
20. TASK CLOSED ACCEPTANCE SIGNATURE	21. DATE
APPROVAL *(Printed or Typed and Signed)*	2014-11-23

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1.	Open this Task Sheet	
2.	**Preparation work**	
2.1	Prepare the Cage	
2.2	Prepare the Temporary Rails: First and second rail section of length 6 meters (TRS (1) & TRS (2)), and third rail section of 3.6 meters (TRS(3)). Each rail section comprises two rails, one at each side (O-TR(X) & I-TR(X))	
2.3	Prepare the beam pipe (BP)	
2.4	Prepare beam pipe valve support (BPVS)	
2.5	Verify that the following hardware is in place -Delphi frame -Cage table (CG_TBL) -TPC, in parking position -TPC A-side supports, TPC C-side supports are installed in the TPC. -Temporary Rails Supports are installed at the Absorber. -Omega platform for access at C side (OMG_PLTF)	

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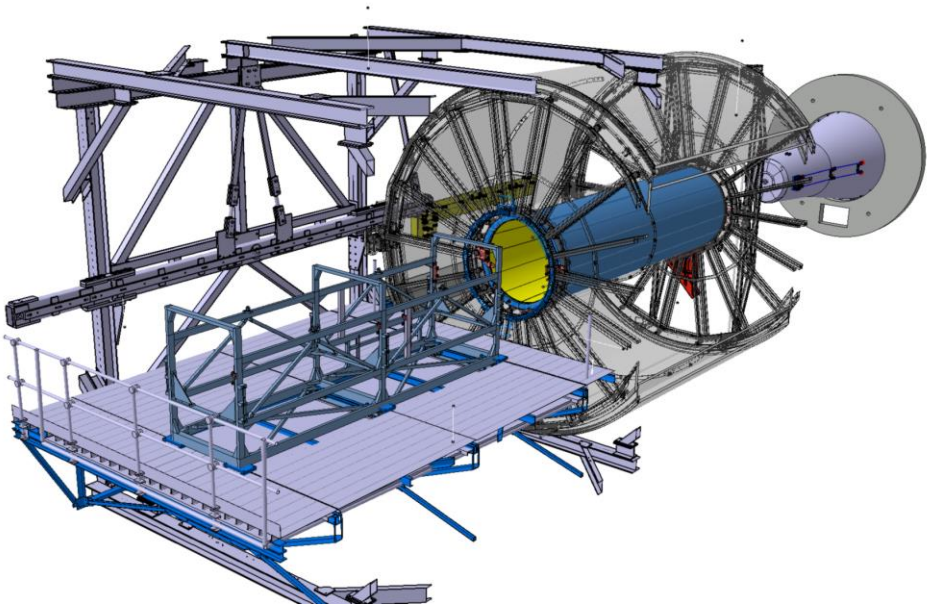
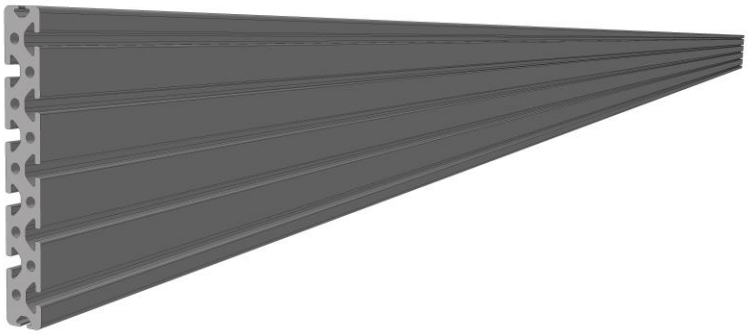


3. Install Temporary Rail Section 1&2

3.1 Open up the top row of rollers from the Cage Table, in order to make room for the Temporary Rails to enter sideways.

3.2 By using the Crane, lower on the Delphi Frame O-TR (1) (weight of single rail 62.2 Kg, update number). To be discussed how to maneuver while lowering in order to save the Delphi Frame top beam. Add pictures of lowering sequence, needed?



Temporary rail

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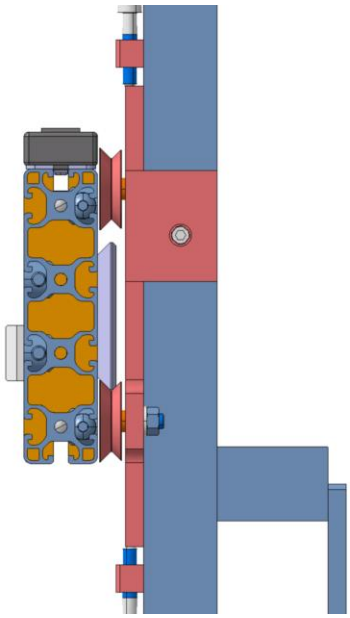
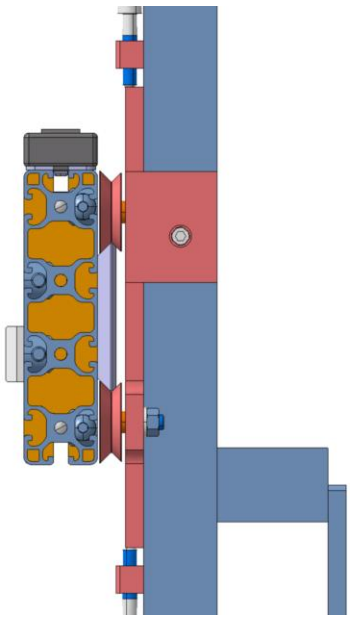
3.3	Once O-TR (1) is down, make it slide inside the Cage Table at O-side.	



Top rollers open

3.4 Close the top row of rollers of the Cage Table so O-TR (1) is held in position.



Top rollers close

3.5 Repeat operation with I-TR (1).

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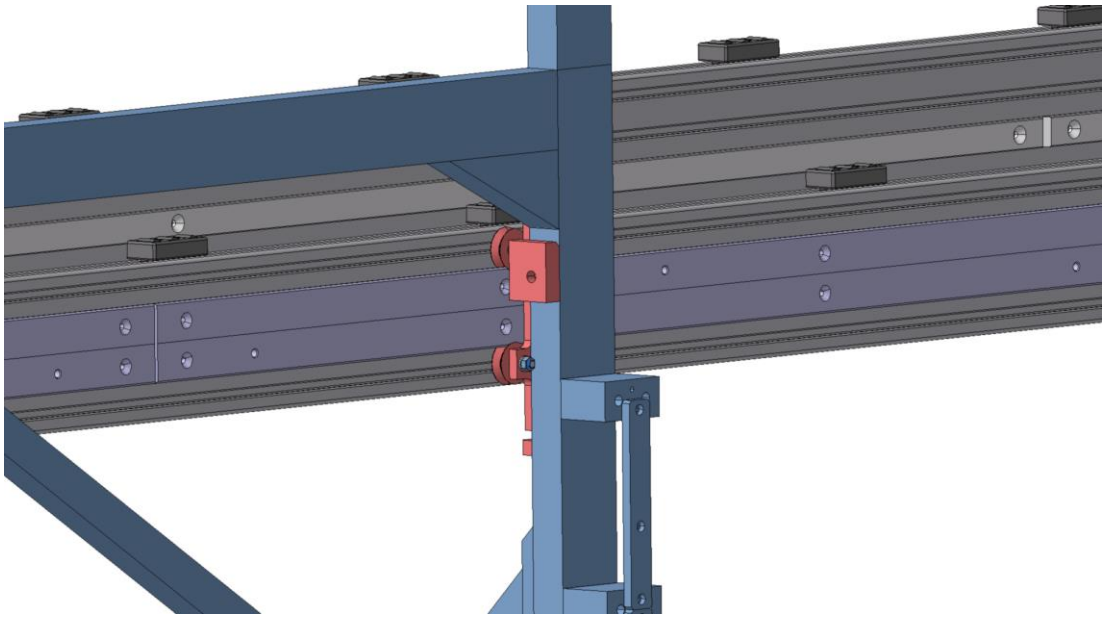

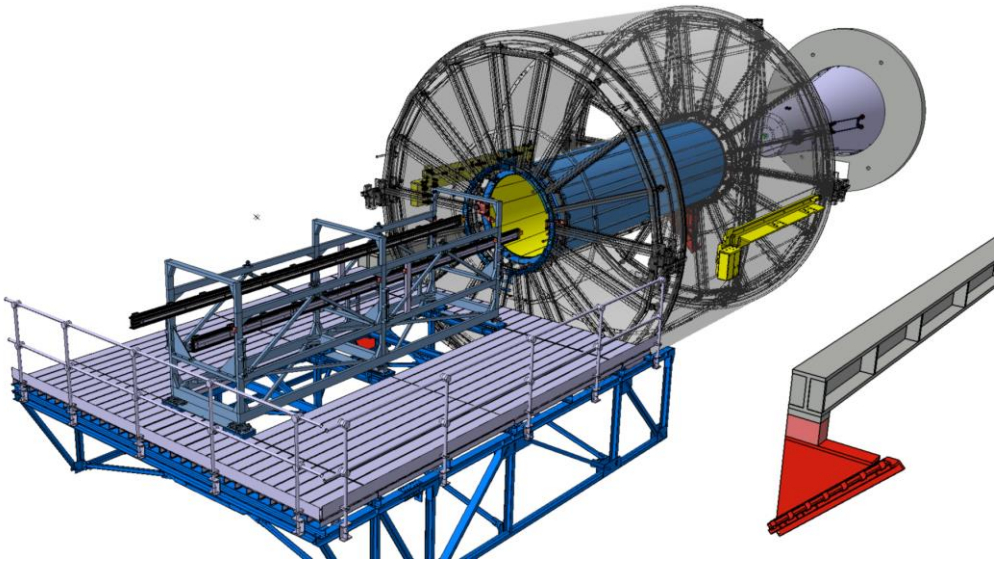

TRS (1) is now inside the Cage Table

3.6 Partially slide out O-TR (1) & I-TR (1) from the Cage Table inside TPC to make room for O-TR (2) & I-TR(2).

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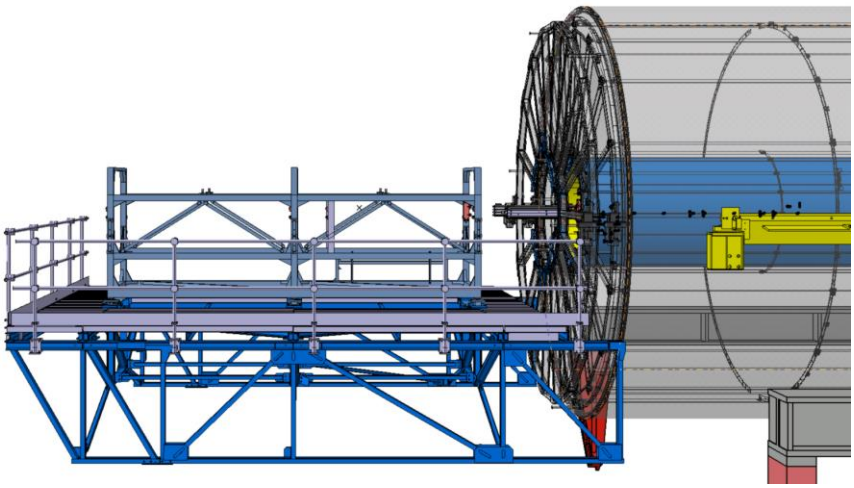
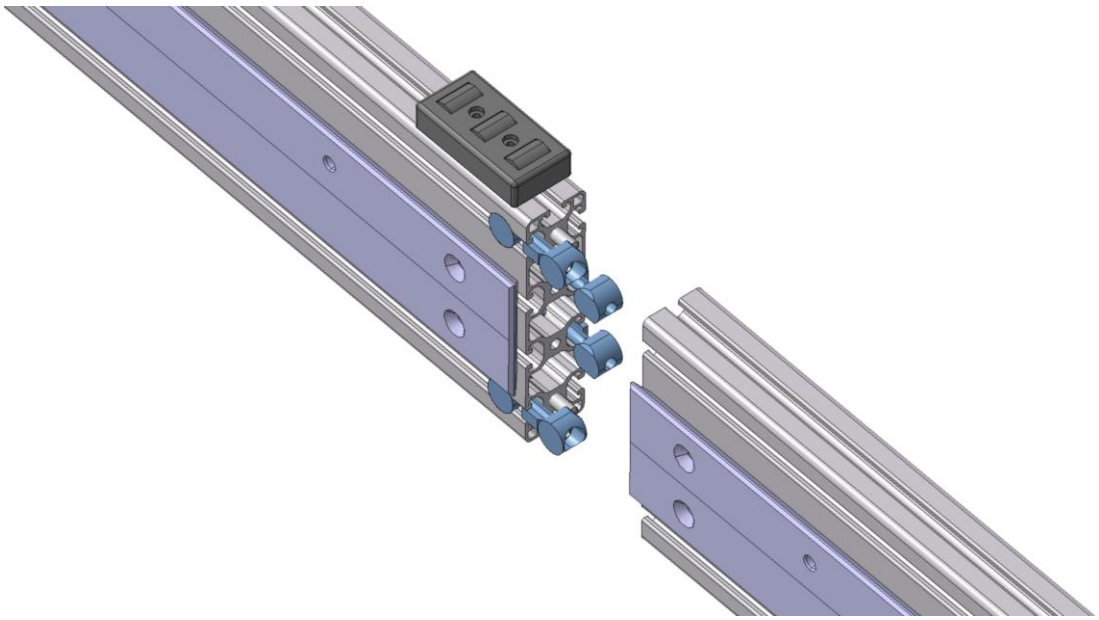


TRS (1) is now inside the TPC in order to accommodate TRS (2)

3.7 Lower O-TR (2) and slide it in the Cage Table following the same procedure as for O-TR (1).

3.8 Make connection between O-TR (1) and O-TR (2).



Connection between O-TR (1) & O-TR (2), x2 pin (diam?) + x4 ITEM links (ref?)

3.9 Repeat operation for I-TR (2).

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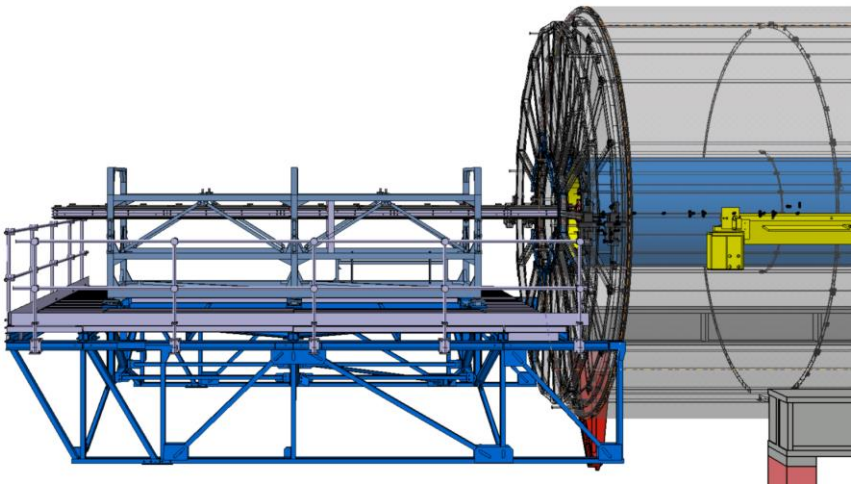
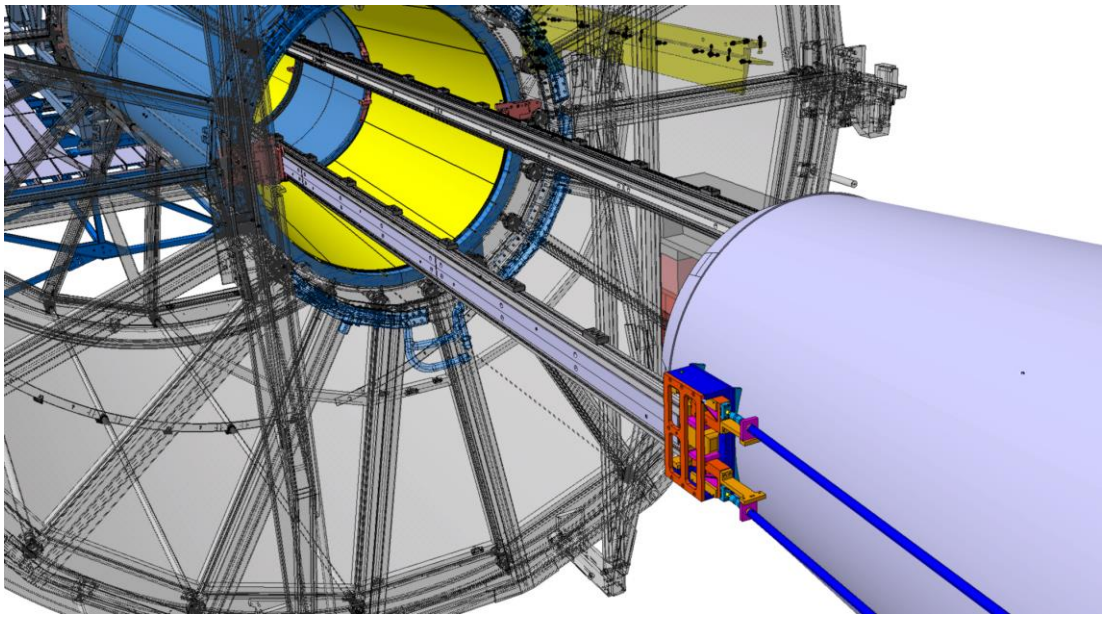


3.10 Push TRS (2) into the TPC in such a way that TRS (1) arrives at the Absorber.



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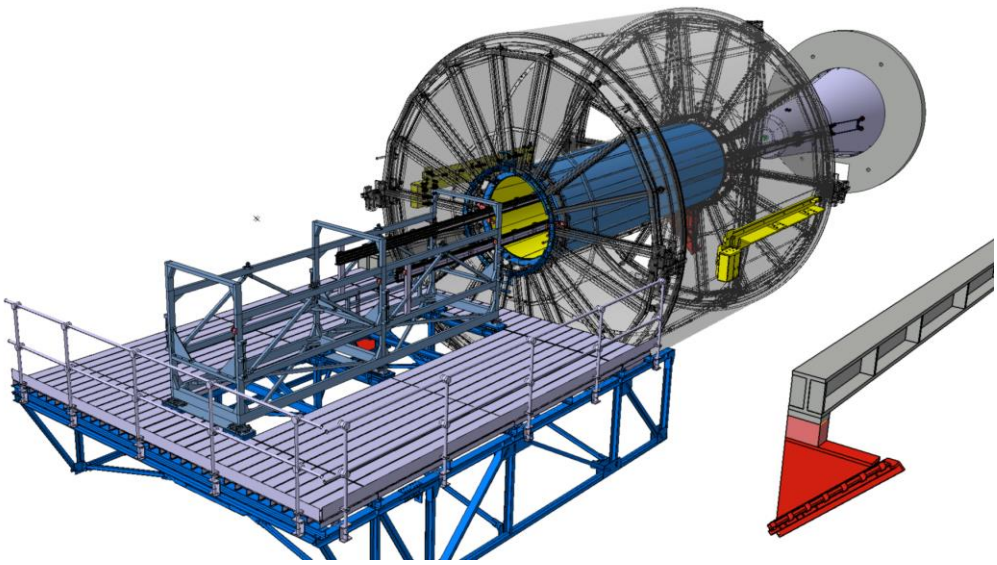
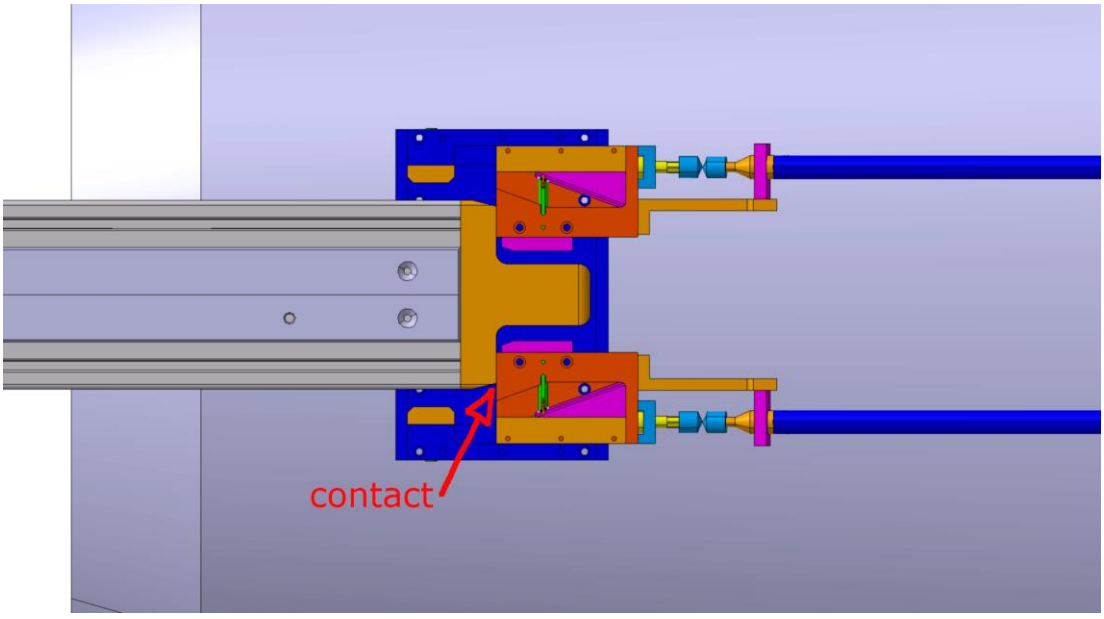


3.11 Make connection between TRS (1) and the Absorber. The end of TRS (1) must be in contact with the support at the absorber side. Clamp…Adjust



3.12 TRS (1) and TRS (2) are now fixed at the Absorber, TPC A-side supports, TPC C-side supports and rollers of the Cage Table.

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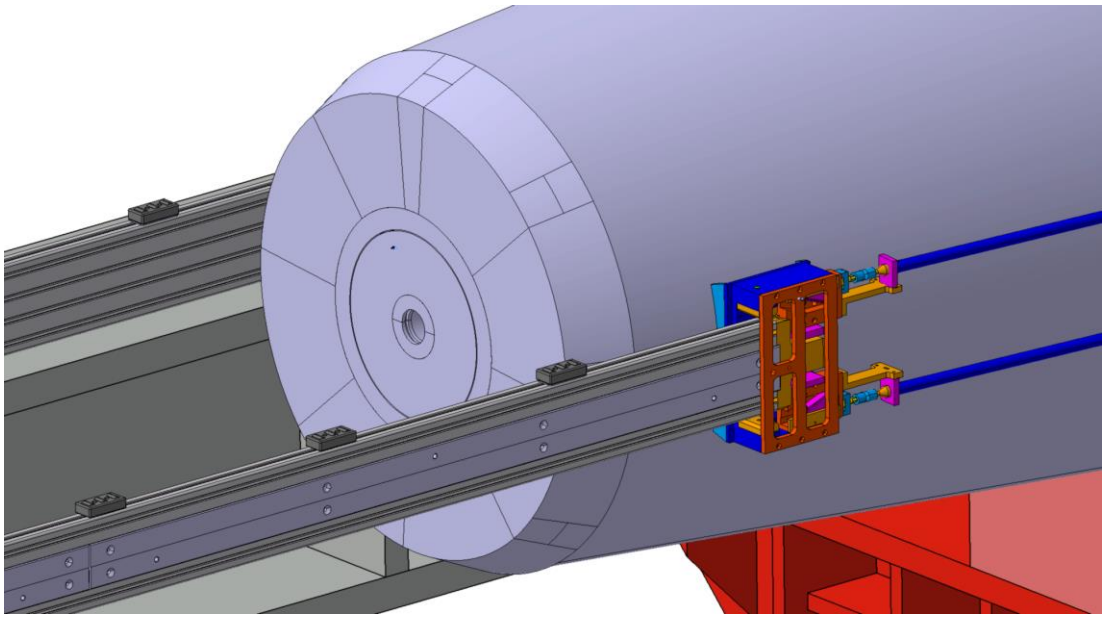
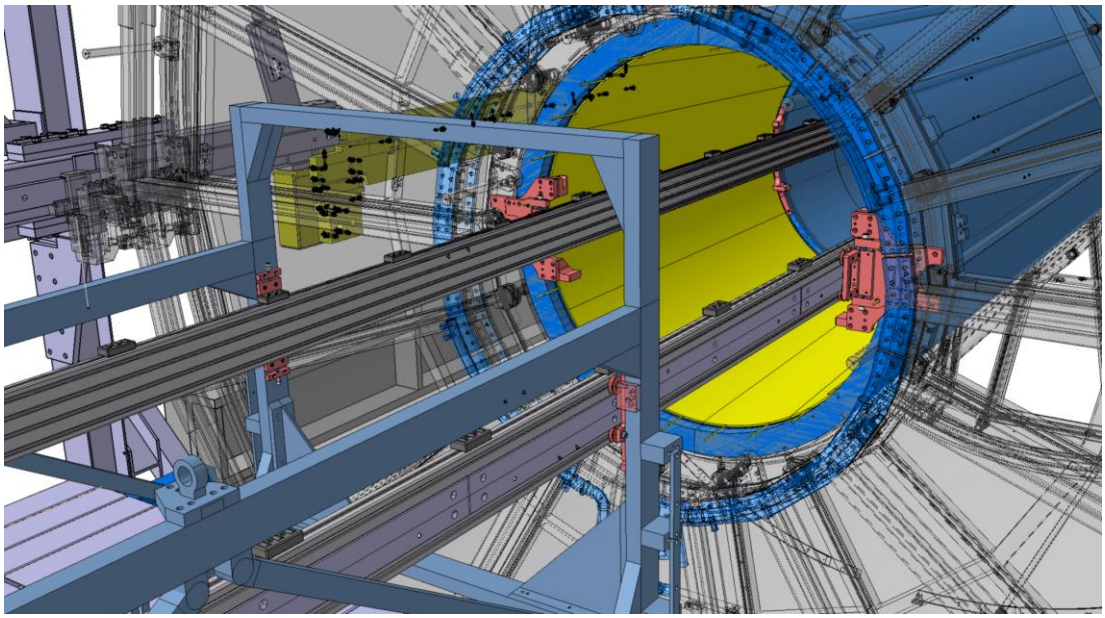


Temporary rails supports at the absorber



Temporary rails supports inside the TPC A side & the Cage Table

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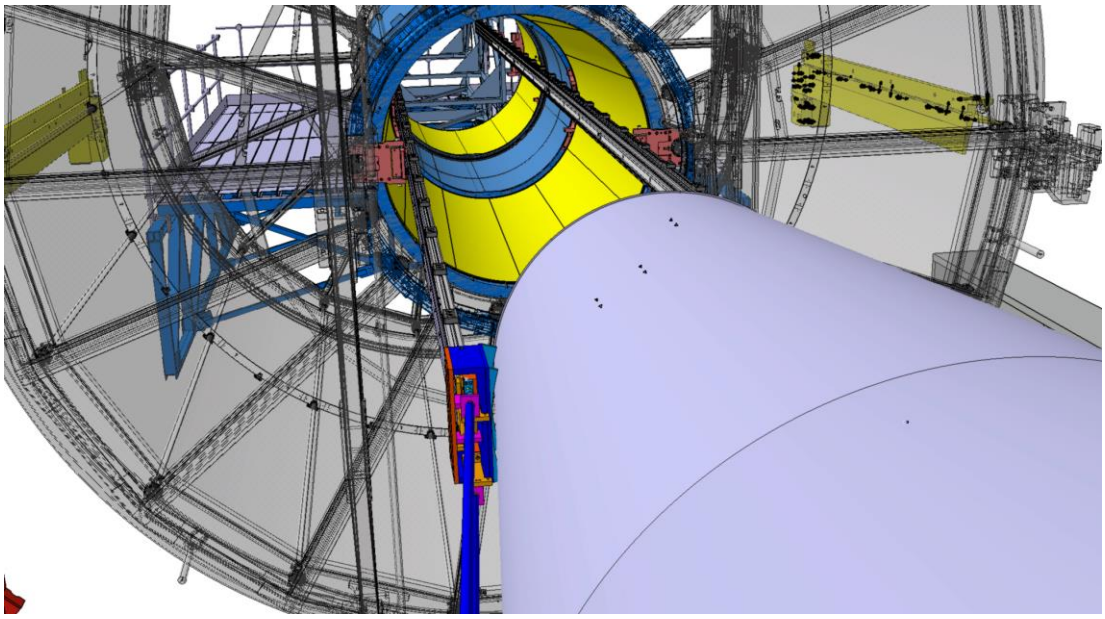

Temporary rails supports inside the TPC C side

4. Install Cage together with Temporay Rail Section 3 and assemble Temporary Support Sistem inside Cage Table.

4.1 Verify that TRS (3) is fixed inside the C-profiles of the Cage, for safety during the lowering phase of the Cage. Also, verify that the reinforcement bars are in place. Finally, verify that the Beam Pipe supports are not installed. To be discussed how to fix it. Add picture of TRS (3) inside the Cage C-profiles showing detail of fixation.

4.2 Lower the Cage together with TRS (3) inside the Delphi frame by the experimental cavern crane. (Cage weight 100 kg, plus rails etc?).

4.2.1 Install hoist ring and hoist blocks at the pre-determined locations in the Cage side.

4.2.2 Connect the Cage hoist ring to the crane and lower it on the Delphi frame. Provide here a more detailed explanation of lowering sequence, TBD after Monday meeting 30/03/2020.

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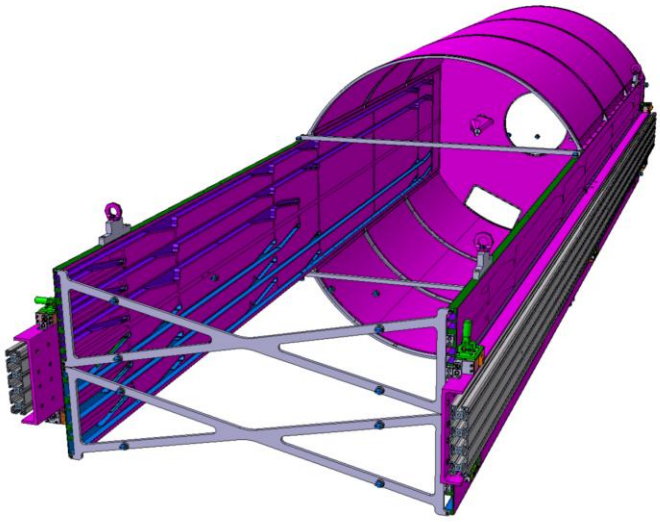
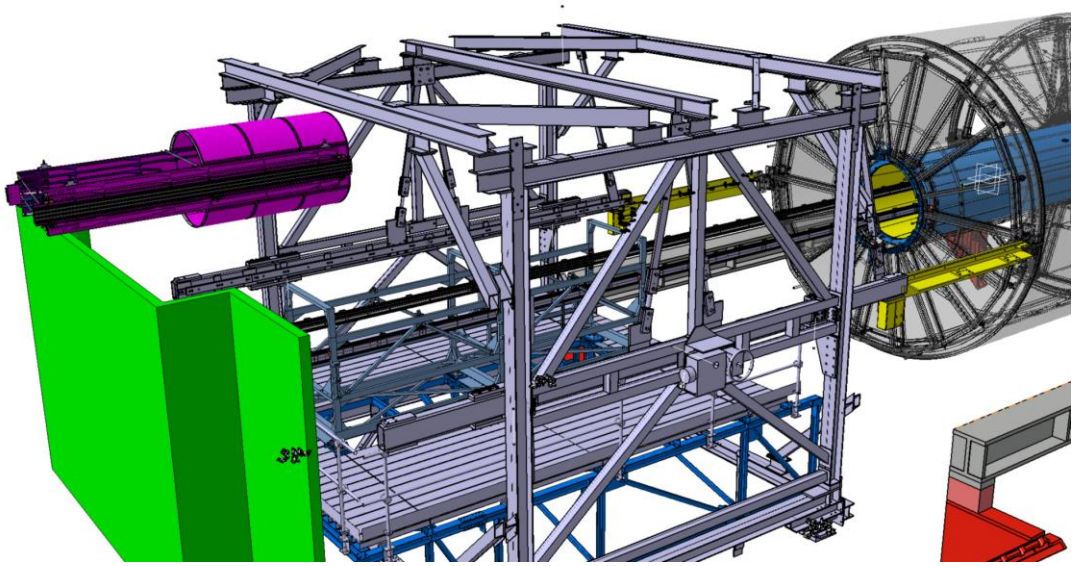


Cage hoist ring



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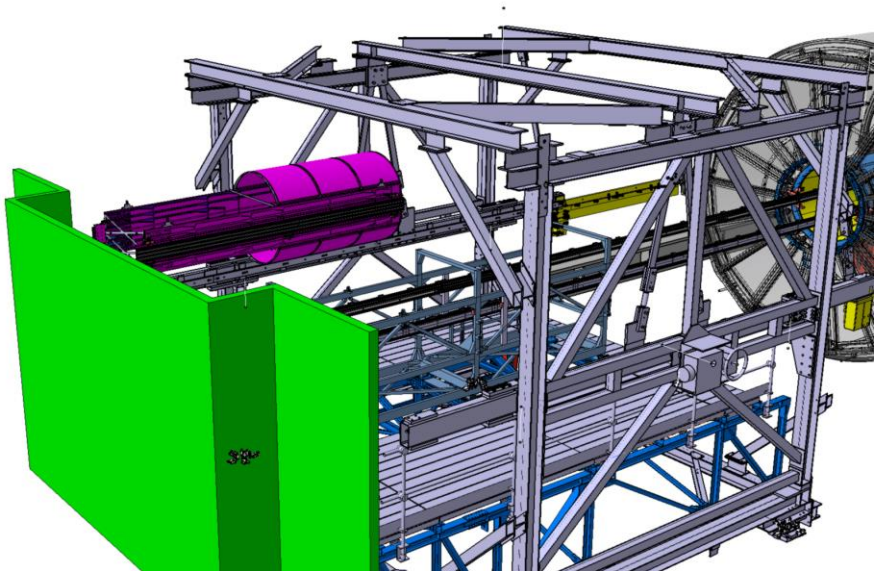

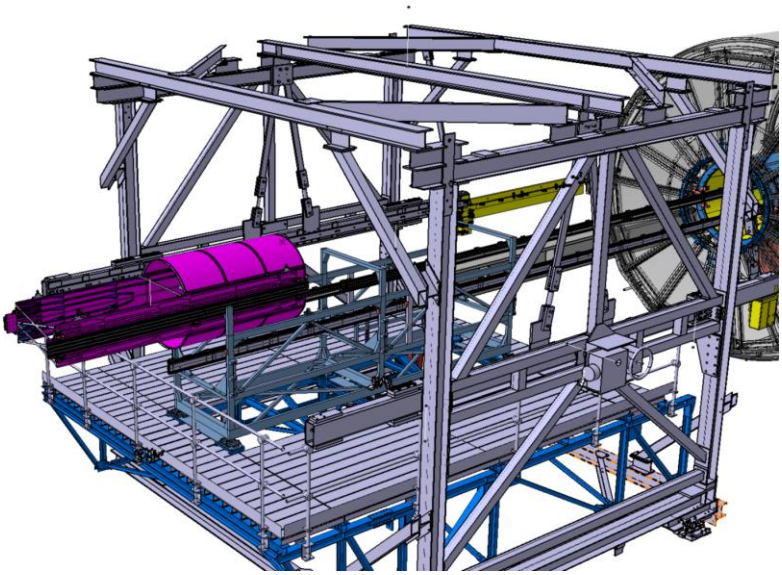

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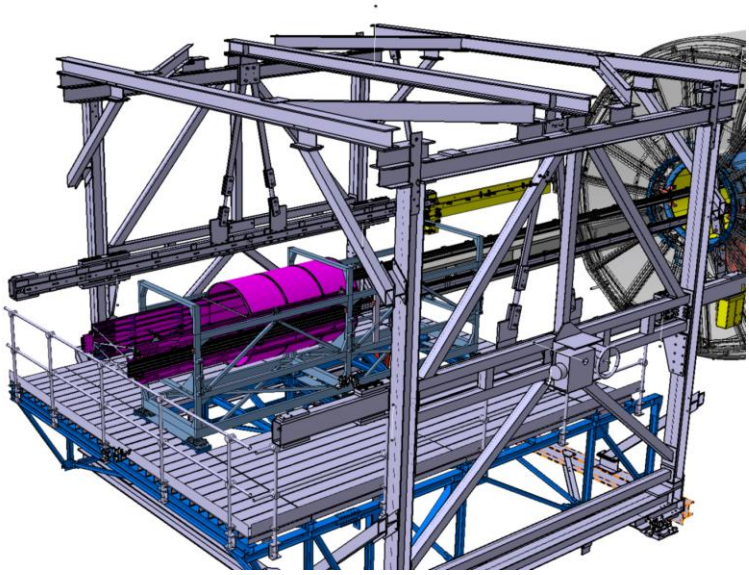
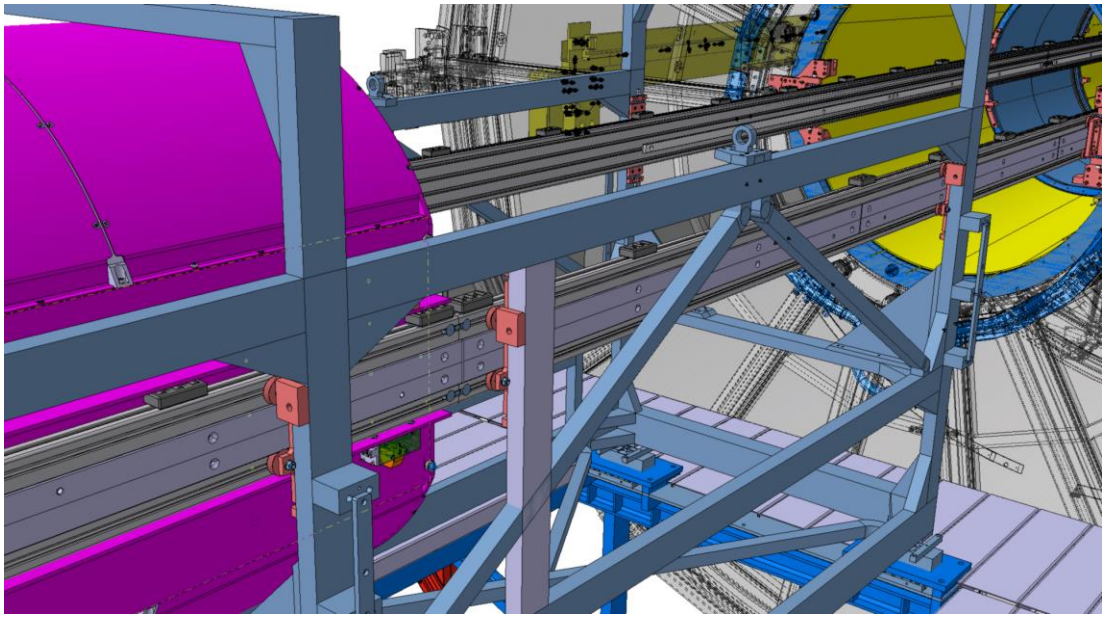


Cage plus TRS (3) lowering sequence

4.3 Install TRS (3) inside Cage Table

4.4 Disconnect the experimental cave crane connection from the hoist rings.

4.5 Make connection between TRS (3) and TRS (2).



4.6 Install the Beam Pipe Supports M & C by fixing first the positioning side and then the sliding side. Add pictures of both supports with cross section of positioning and sliding side

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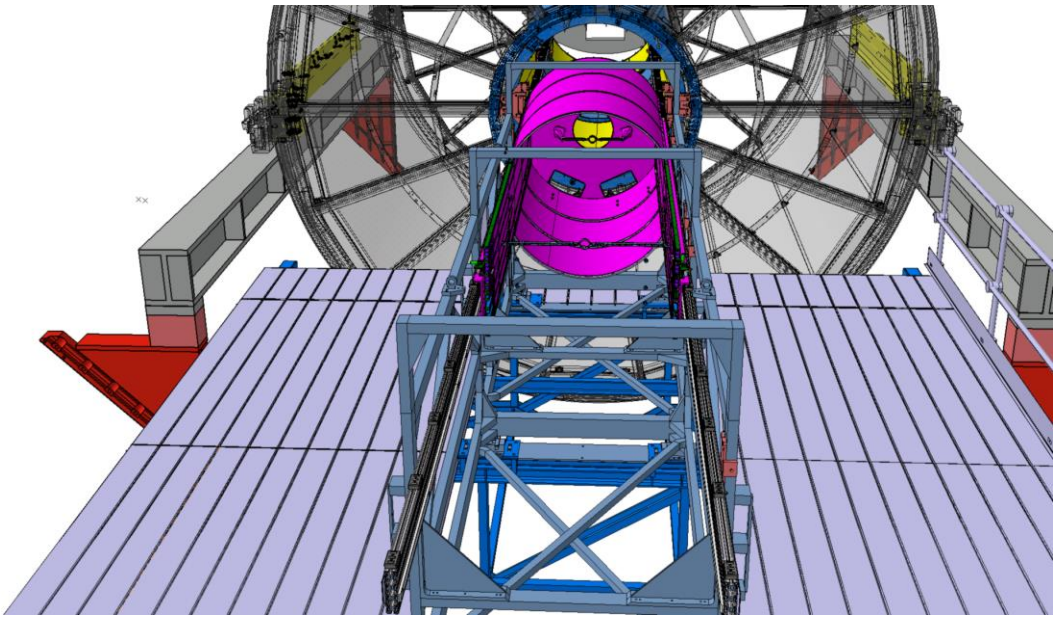
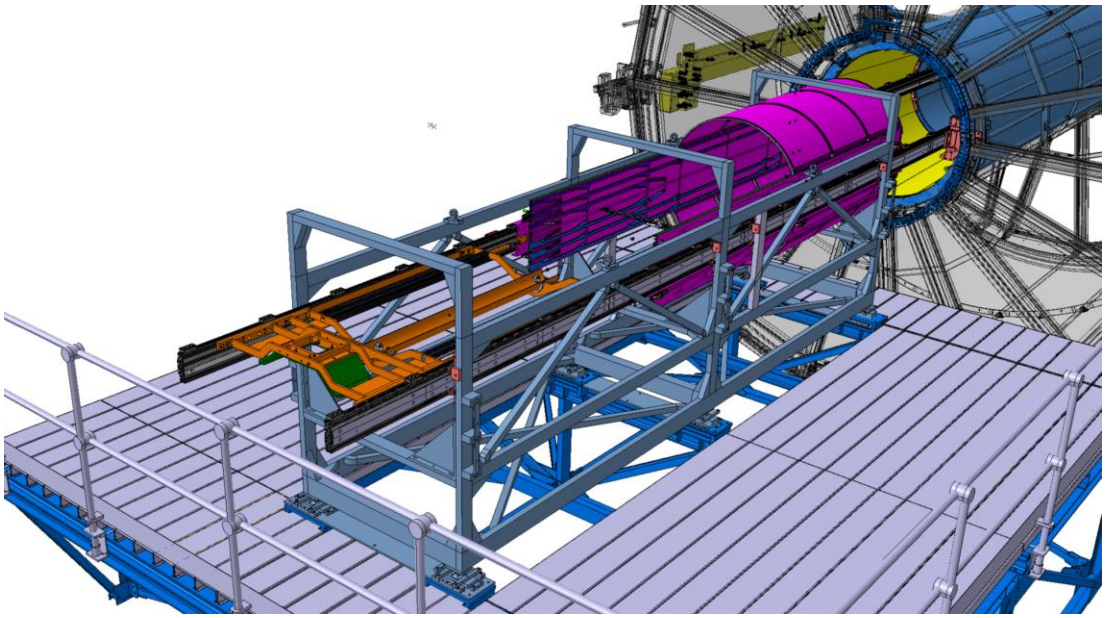
4.7	Remove fixation between Cage and TRS (3) and slide Cage slightly out from Cage Table, just enough to make room for Temporary Support System assembly. 	
4.7.1	Assemble the BP A side Temporary Support System (BP-TSS) inside TRS (3) consisting in (Update list of components and define assembly procedure, TBD with Gael, add pictures of assembly procedure) -the BP A side Temporary Support BP-TSA, -the BP Valve Temporary Support BP-TSV, -the link between the Cage and the BP Valve BP-TSLink.	



BP Valve Temporary Support

4.8 Adjust the Mechanical Bars that link the Cage to the BP valve? Adjust the BP Valve position along z such the the BP is in the correct position. Verify BP versus BP_M_Support.

5. Cage Dry insertion test

Before the BP installation inside the Cage, perform a dry insertion test of the Cage, together with the Temporary Support System. Install the Mechanical Bars that link the Cage to the Temporary Support System. Move the Cage along the rails through the TPC to the final position (TBD, pushing the Temporary Support System?) Monitor rails sagging or deflection all along the insertion. Local sagging must not exceed 5mm.

5.1 Verify interfaces during the insertion and in final position.

5.2 Move the Cage back to initial position.

6. Install the beam pipe in the Cage

6.1 Prepare the Cage for the beam pipe installation

6.1.1 Open the two top covers closer to C-side.

6.1.2 Remove front Cage crox-top.

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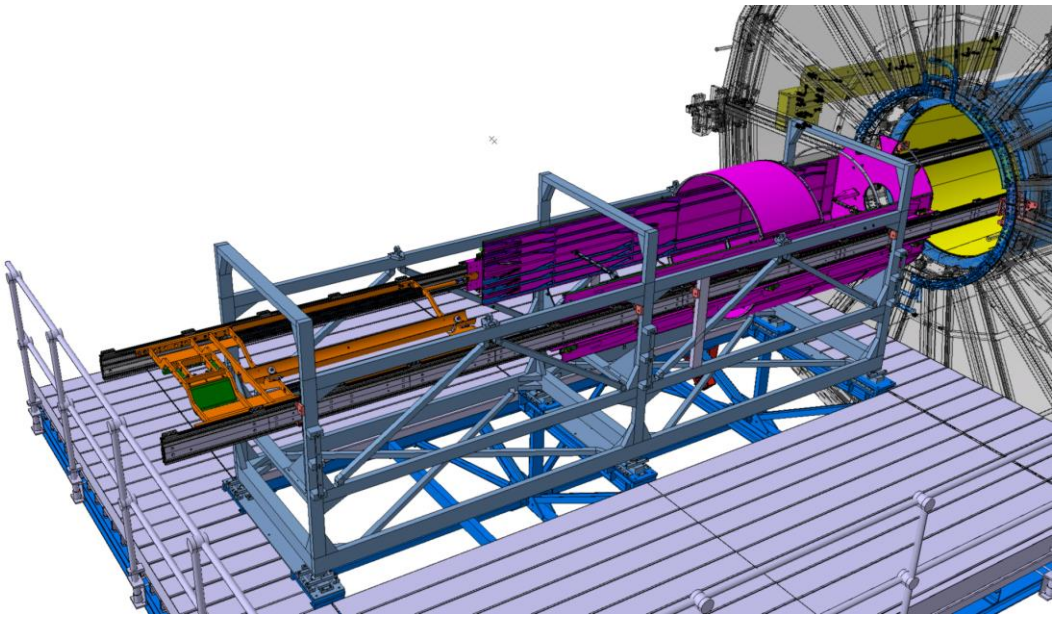
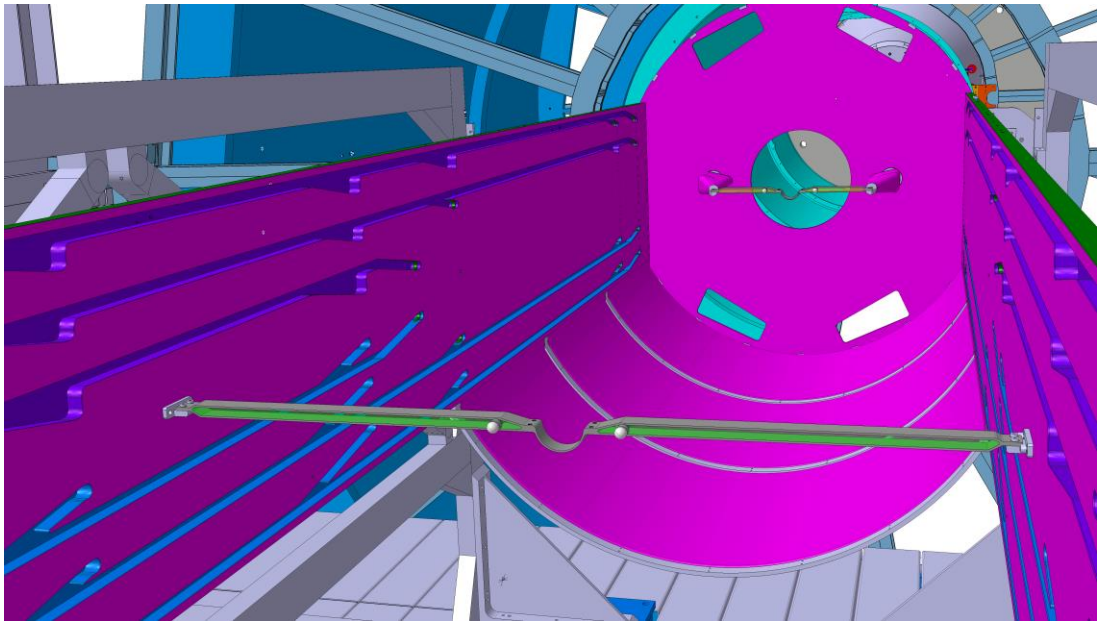


6.1.3 Remove BP-M-support and BP-C-support top bracket. Store for next use. Update picture



6.2 Install the beam pipe inside the Cage. Beam Pipe is to be installed by hand. (TBD, how many people holding it, location of people, etc)

Contact CERN TE/VSC Vacuum Group responsible of this procedure.

Follow CERN VC procedure N. ##_____

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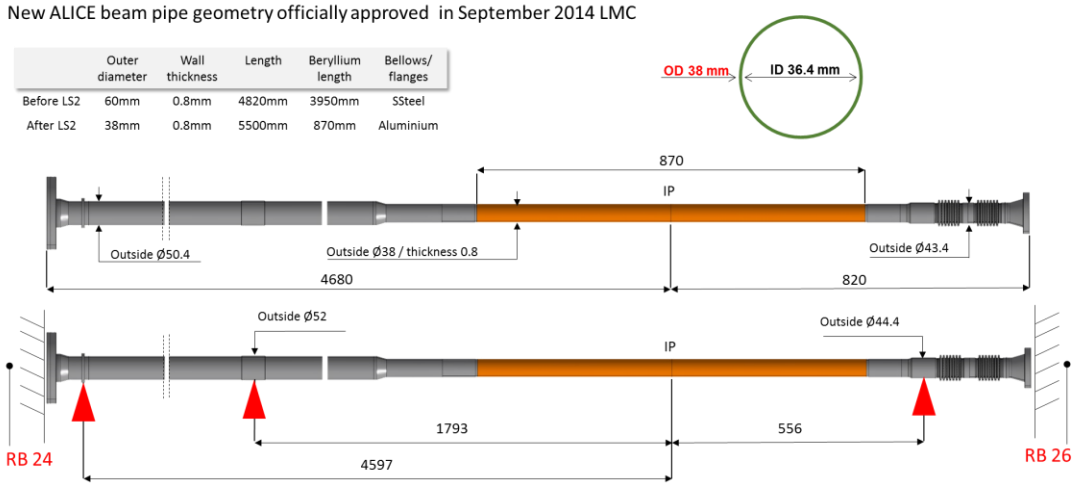
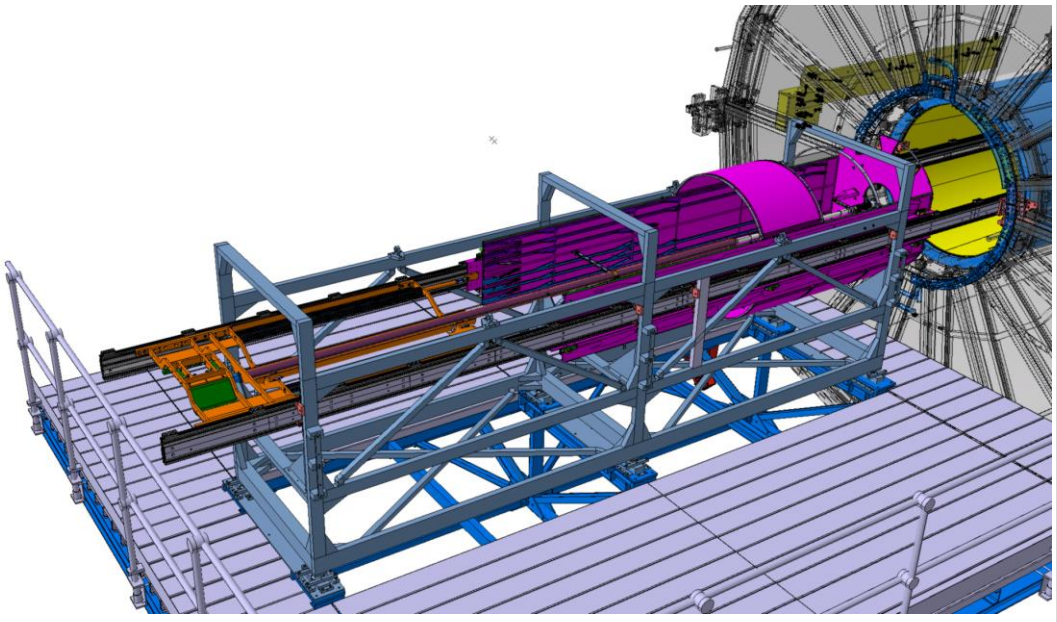
New ALICE beam pipe geometry officially approved in September 2014 LMC

	Outer diameter	Wall thickness	Length	Beryllium length	Bellows/ flanges
Before LS2	60mm	0.8mm	4820mm	3950mm	SSteel
After LS2	38mm	0.8mm	5500mm	870mm	Aluminium



The following steps are here only as draft that will be discussed with TE/VSC, they will then be removed and replaced by the TE/VSC procedure.

6.2.1 Bring the Beam Pipe by hand and transfer it gently on the beam pipe supports, A-temp, M and C supports



6.2.2 Verify that the BP is well seating on the supports and aligned.

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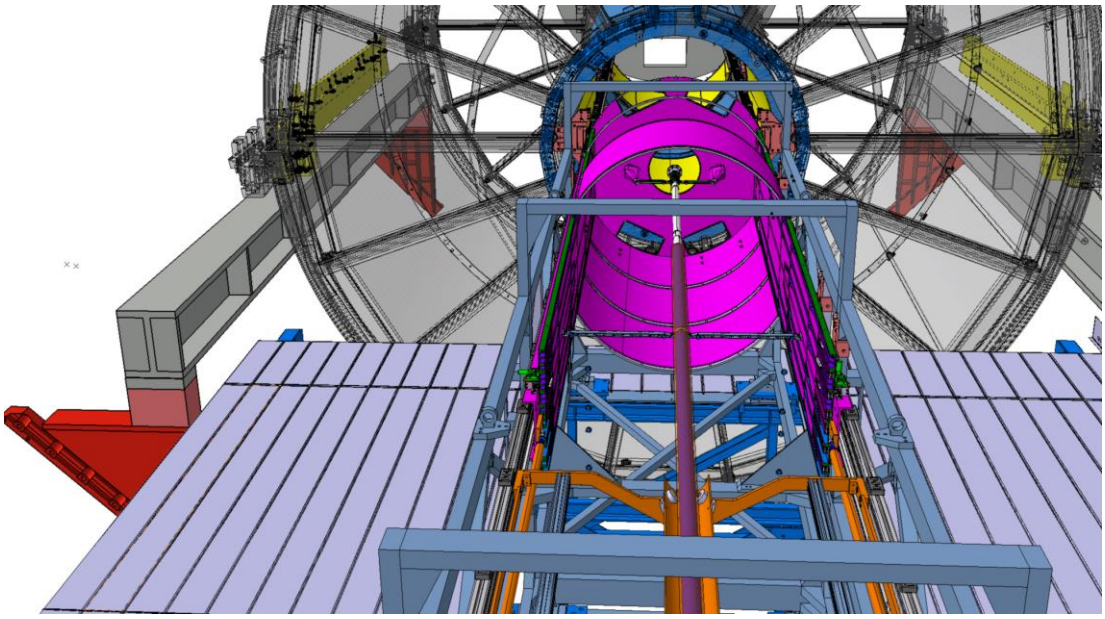

6.3 Contact CERN VC Group responsible to verify BP installation has been completed

6.4 Re-mount front Cage crox-top and Cage top covers. Add global picture showing the Beam Pipe inside the Cage

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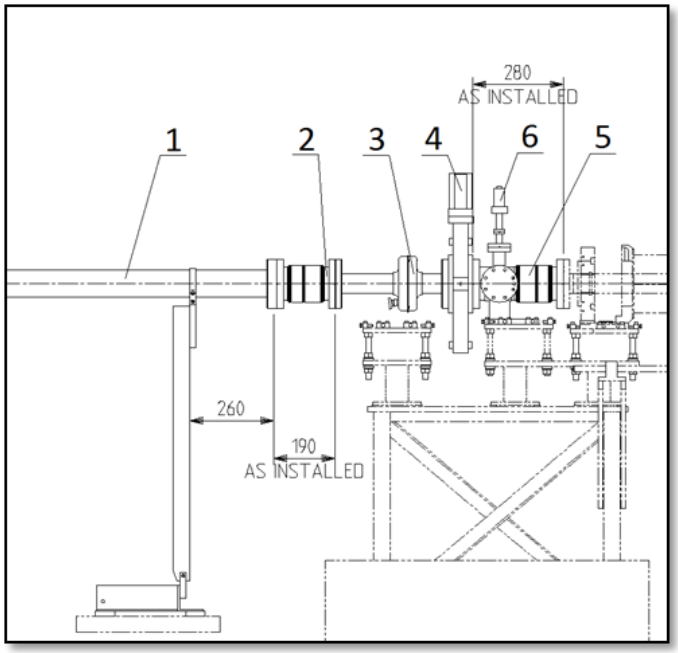
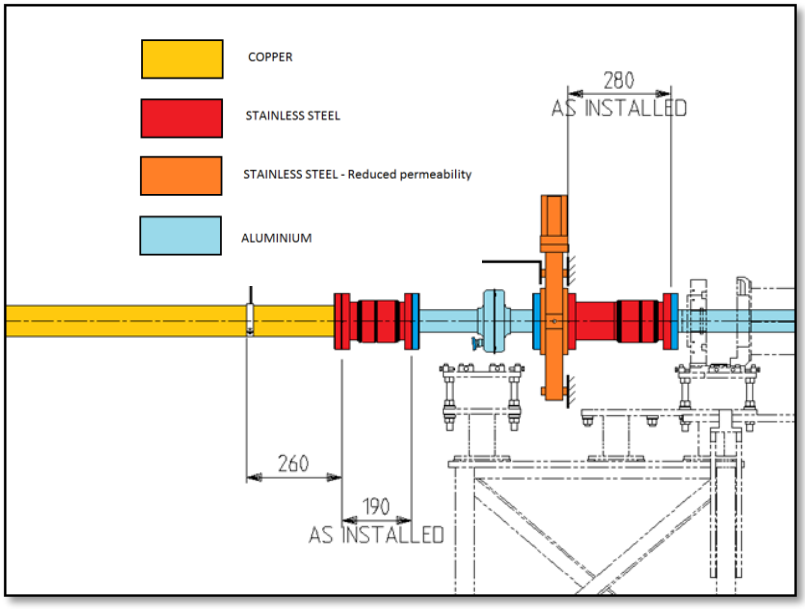
7. **Central valve and temporary support Review the sequence with Corrado and Gael on Monday 30/03/2020**

7.1 The BP Valve group and the modification respect to Run 2 are described here below. Update drawings and equipment definition.





BP box seating on BP support C, and support M

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1. RB24/1 vacuum chamber.

Equipment name (LD: VC2UB.A1L2.X; CDD: LHCVC2U_0035).

- Extension of a new central beam pipe would be compensated by shorter RB24/1 vacuum chamber.
- VSC will use generic chamber design from LHC (VCDBF).
- RB 24/1 Sliding support (LHCVC2U_0034; Pos. 14) will disappear and will be integrated as a part of a new support of VVGMT manual valve (LHCVC2U_0034; Pos. 11).

2. Warm module Type VMACA

Equipment designation (LD: VMACA.C1L2.X; CDD: LHCVMACA0002)
Will be reused – no change.

3. VC2UA chamber with annular ion pump.

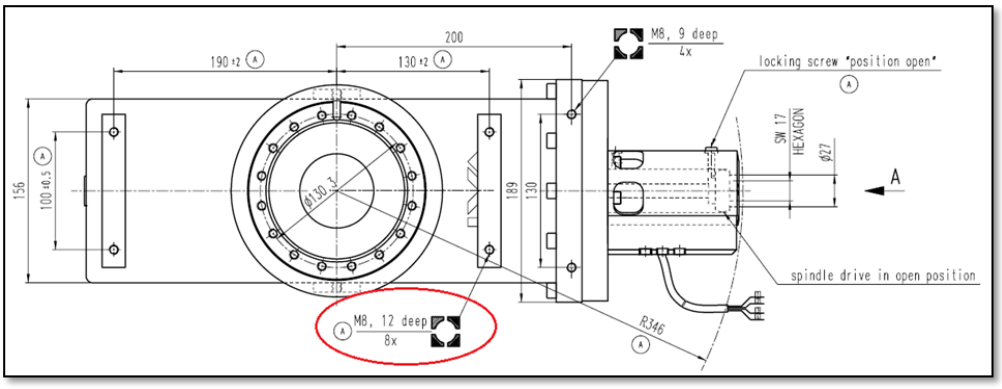
Equipment name (LD: VC2UA.A1L2.X; CDD: LHCVC2U_0030)

- Will be produced as an "aluminium" design, based on experience with ATLAS.
- 3x bimetallic flange (1x UHF Fixed OD 152 ID 60 – transition to 63; 1x UHF Rotatable OD 152 ID 60 – transition to 63; 1x LHCVC1AP0016)
- 2x Annular ion pump half-cell; extension with tube OD 60; material AW2219
- 1x Annular ion pump RF screen; material AW2219
- Set of VARIAN pumping elements.
- VSC would like to keep 1 installed + 1 spare.

4. Manual sector valve VVGMT

Equipment name (LD: VVGMT.B1L2.X; VAT: 47236-XE05-ADQ1)

- Will be reused – no change.
- VVGMT will be used as a fix-point support. Valve will be attached by M8 screws.



- VSC would like to keep 1 installed + order 1 new spare.

5. Vacuum assembly on IP2.X vacuum sector

Equipment name (LD: VAMXF.A1L2.X)

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	○ In order to minimize background the Pirani gauge will be removed (see point 6. for more details). ○ Warm module VMABD (CDD: LHCVMABD0001) will be replaced by warm module type VMABB (CDD: LHCVMABB0002). This change implicates relocation of Fix-point from VAMXF assembly to a new VVGMT support. ○ VMABB will be equipped with standard RF contact and RF insert. ***6. Pirani gauge.*** Equipment name (LD: VGRB.42.1L2.X). ○ Will be relocated to DCUM 3351.4674 m (VVGSW sector valve between RB26 and LHC A1R2.X sector). ○ Pirani will be accommodated to modified VVGSW (with additional DN 16 CF-F port). This solution requires removal of current cabling and pull the new one from UA27. ***7. Other remarks*** Bellow between VVGMT manual valve and central beam pipe VC2C stay in place due to alignments of central beam pipe (when the bellow is not present the central beam pipe needs to be aligned together with manual valve (+25kg).	
7.2	Fix BP flange A side to BP support, install transversal support bracket across the TRaislsclamped to the BP Valve Temporary support	
7.3	Install BP Valve block and connect to the BP central section Update picture	

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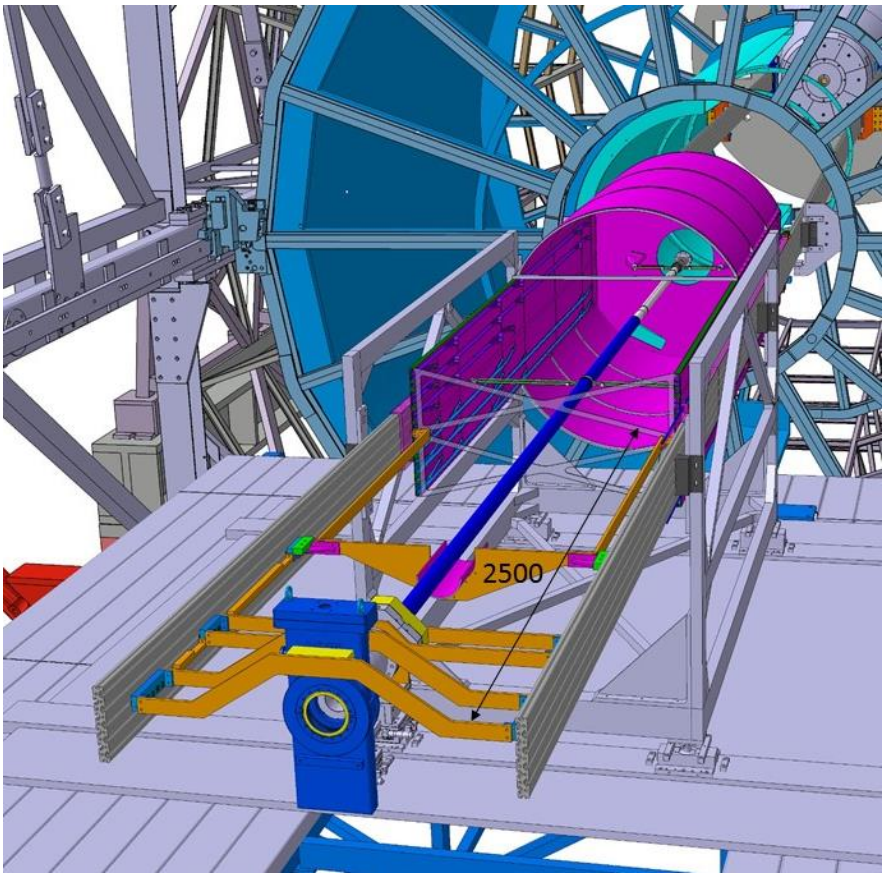
11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PWE



8. Move the Cage to its final position

8.1 Verify that the temporary rails supports are fixed on the different support points.

8.2 Verify that the BP Valve is fixed to the Cage by the mechanical bar

8.3 Verify that the top crox and the top covers of the Cage are in place

8.4 Move the Cage along the rails through the TPC to the final position (pushing from the Temporary Support System?). Monitor rails sagging or deflection.

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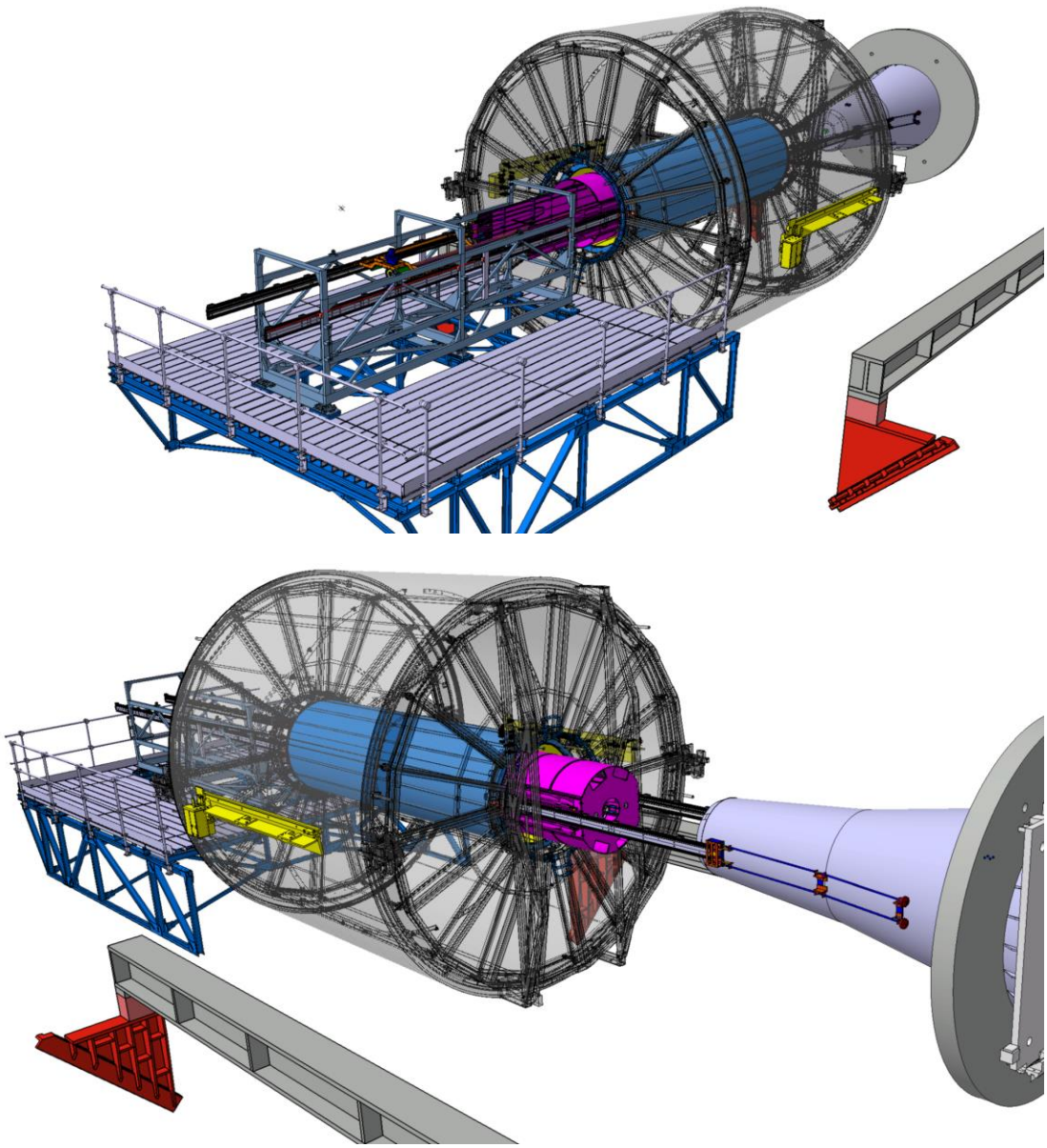
11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PWE
		
8.5	Locate the Cage in its final position, taking reference form the absorber, i.e. isntall calibrated spacer in between cage bottom and absorber.	

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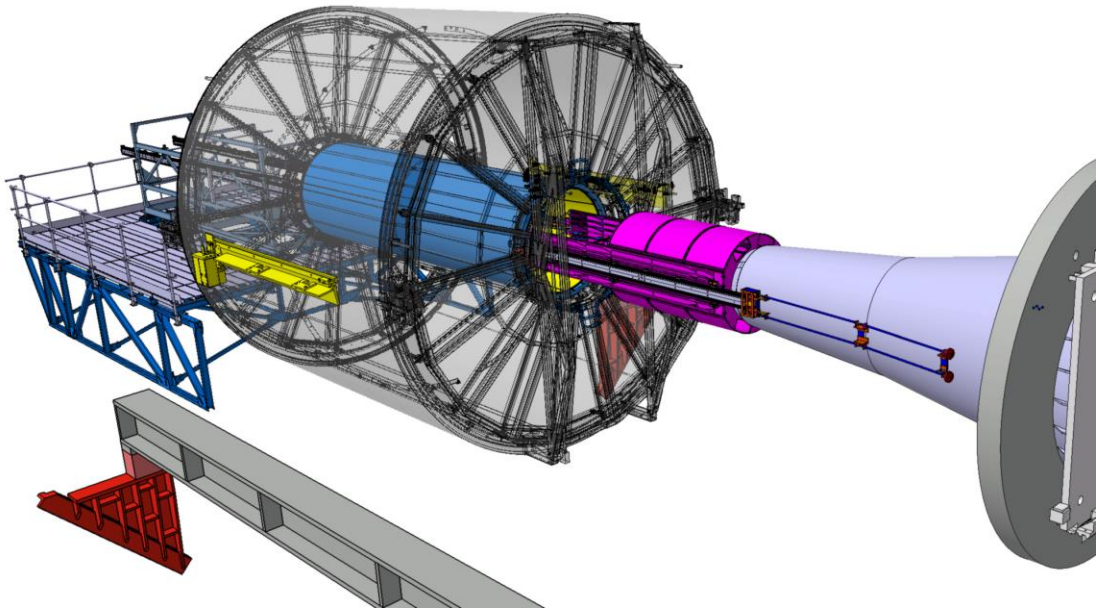
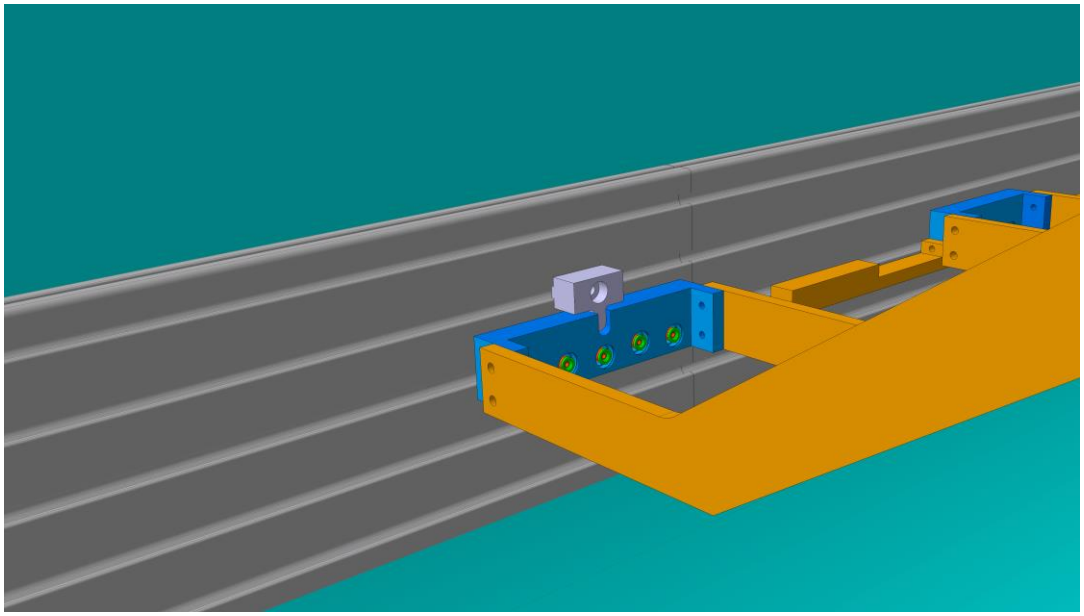
11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PWE



8.6 Block the Cage and BP by locking the BP-tSS to the temporary rails. Note this step is critical, the Valve has to be locked otherwise during the BP bake out the valve will be pulled in the absorber direction and will squeeze the bellow due to the action of the vacuum.

This requires access inside the TPC!!! TBD



Update picture

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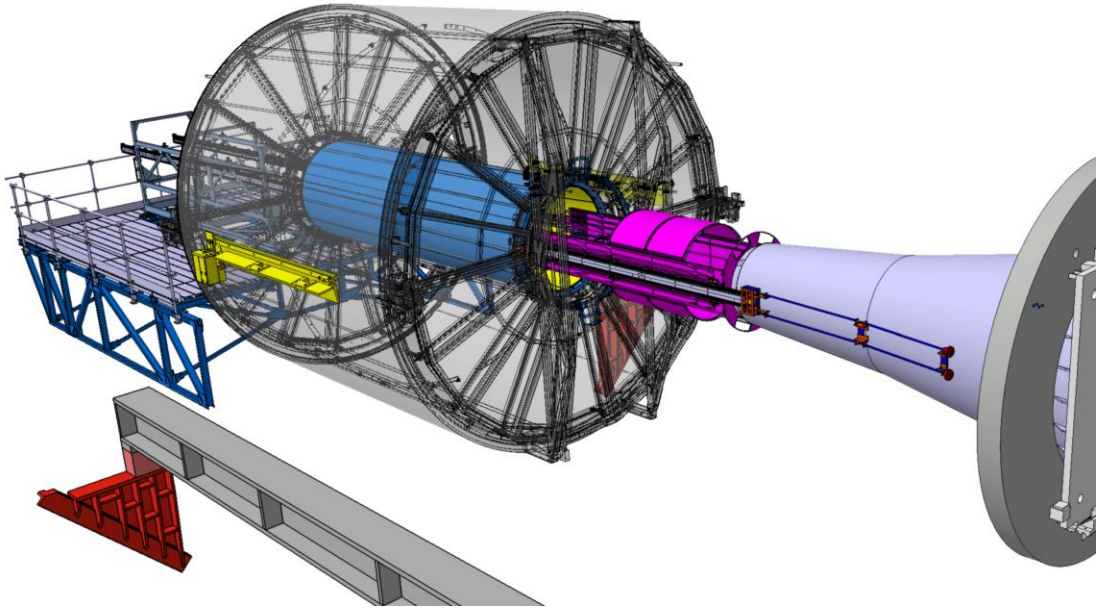
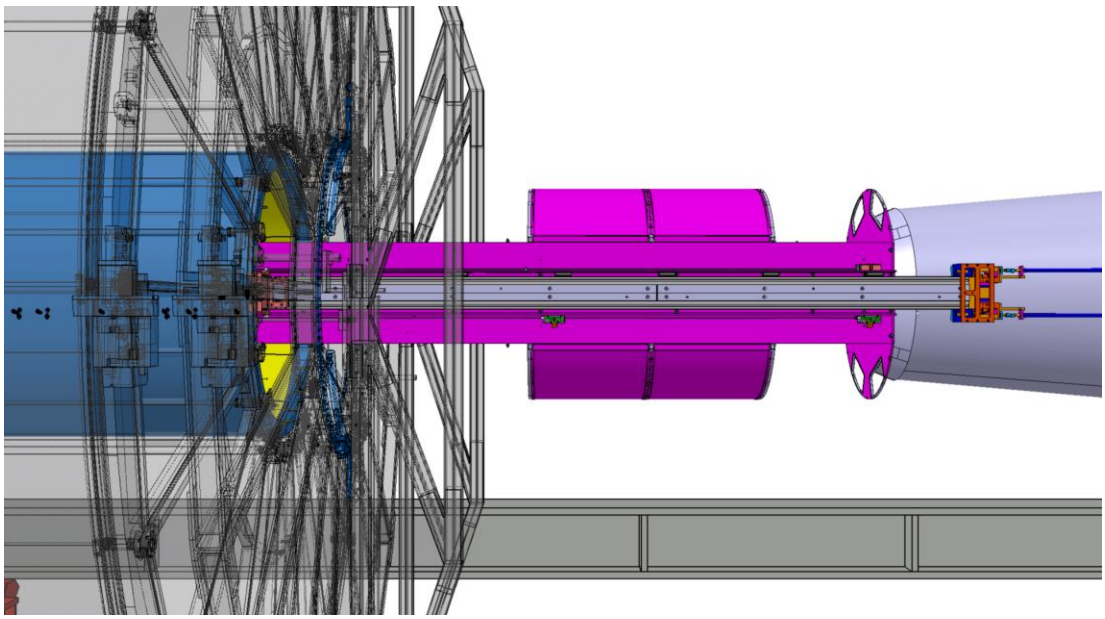
11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PWE

9. **BP connection and bakeout**

9.1 Access the Omega platform at the C-side. Add picture of Cage with covers on and Omega platform in place

9.2 Remove only the closest top? & bottom carbon covers from the C-side to provide access for BP connection.





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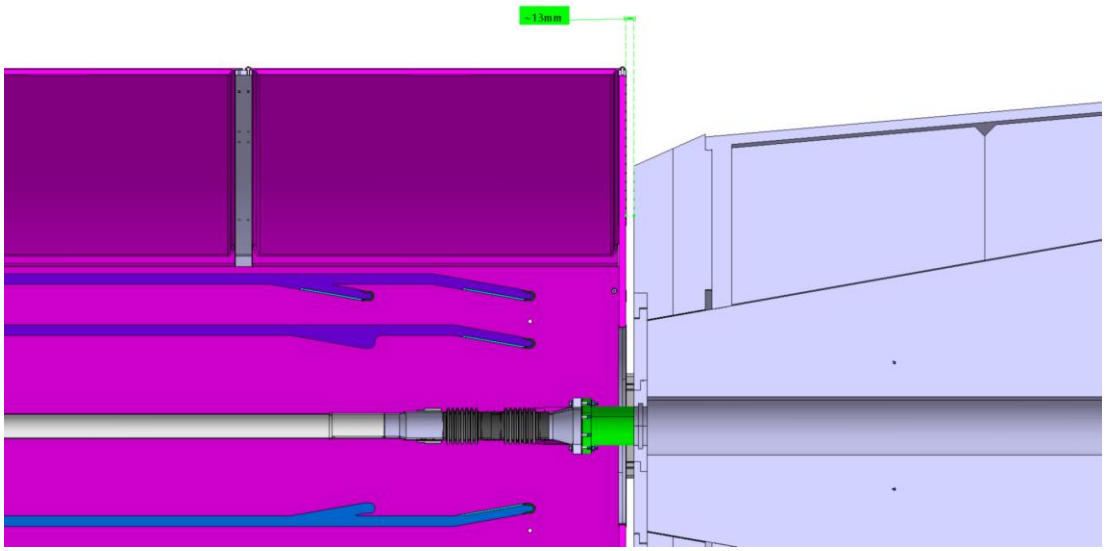
11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PWE
9.3	Contact CERN VC Group responsible for the procedure for beam pipe connection and bake out. Follow CERN TE/VC procedure n. _____ *The following steps are here only as draft that will be discussed with TE/VSC, they will be then removed and replaced by the TE/VSC procedure.*	
9.3.1	Remove the bellows protection	
9.3.2	Install the top bracket of BP-M-S and BP-C-S inside the two BP supports in the Cage. Keep brackets bolts loose	
9.3.3	Connect the BP flanges at absorber side, this connection will require to stretch the bellow by 15mm.	
		
9.3.4	Pull vacuum and verify it by helium test. This mini-vacuum cycle does not exert any relevant resultant force because the vacuum is applied from two symmetric locations.	
9.3.5	Install bake-out standard equipment on the BP beryllium and bellow central section, the aluminum section is equipped with permanent bake-out equipment	
9.3.6	At least one of the Top carbon shells must be removed to help evacuate the heat during bake-out. Already on a previous step, 9.2?	
9.3.7	Perform bake-out. The heating cycle is set at either 240 ° for 24h or 180 ° for 48h. Should the temperature surpass the max allowable temperature that the Cage and TPC may sustain, there are various solutions: 1)installing a thermal screen around the BP to avoid direct radiation, 2) install thermocouples in strategic locations and start a fan system when T>T_max (not ideal since it will spread out the heat, thus affecting other detector components).	

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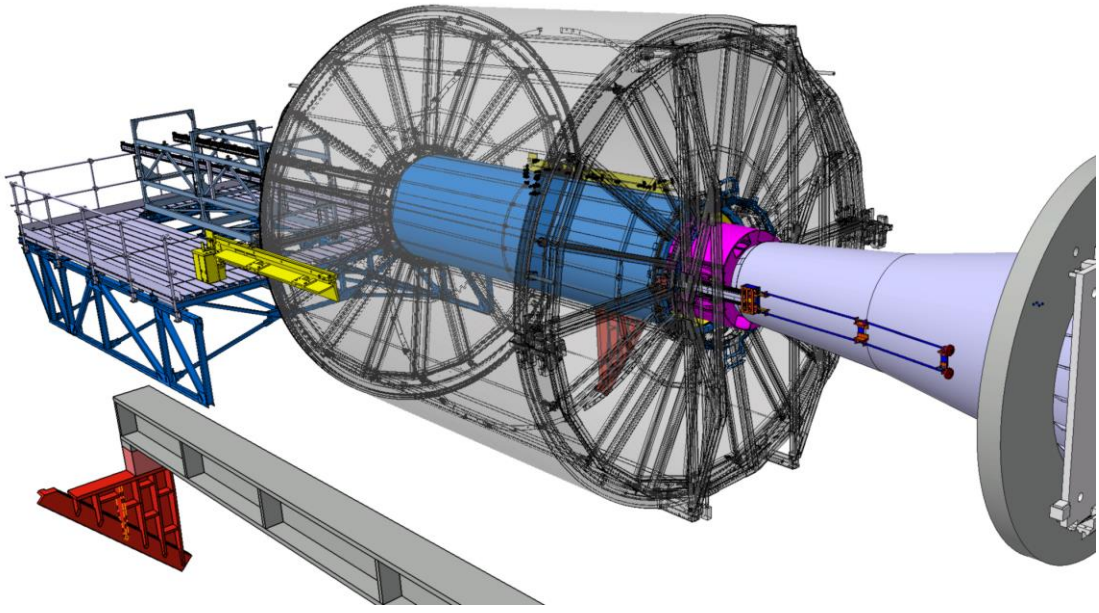
11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PWE
9.3.8	Install BP supports M and C top clamp	
9.3.9	Survey at this point?	
9.3.10	Remove bake-out equipment.	
9.3.11	The vacuum phase is carried out. During vacuum phase, the force exerted on the valve is around 110 kg, so the valve must be well fixed to the temporary rails.	
9.3.12	Fill the beam pipe with nitrogen.	
9.4	Contact CERN VC Group responsible for the BP installation. Verify BP bake-out has been completed	
9.5	Tighten the top bracket of BP-M-S and BP-C-S	
10.	**Move the TPC to its final position**	
10.1	Close the Cage Top & Bottom covers.	
10.2	Move the TPC to final position.	
10.2.1	Move the TPC and continuously monitor the movement of the TPC and of the temporary rails. TPC movement is covered by TC procedure n. _____	
10.2.2	Verify that the TPC and rail movement do not exceed 5mm. If the movement exceed 5mm stop the displacement of the TPC and readjust the temporary rails supports inside the TPC such to contain the rail displacement within 5mm.	



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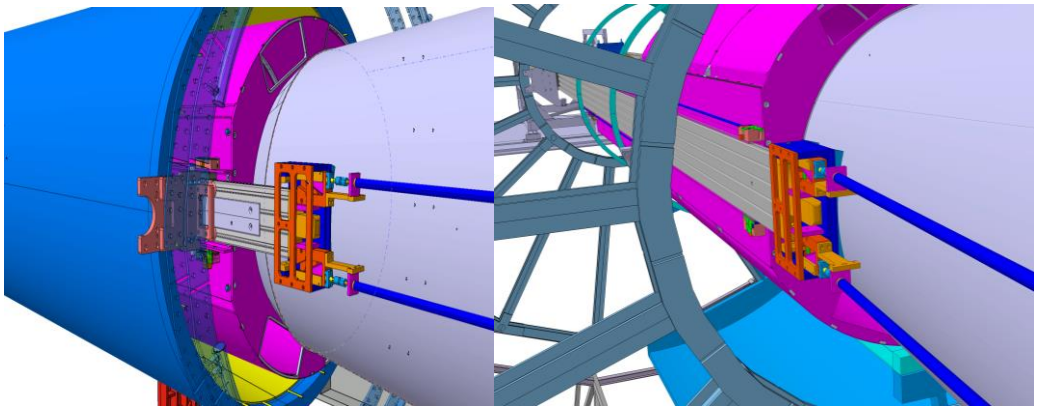
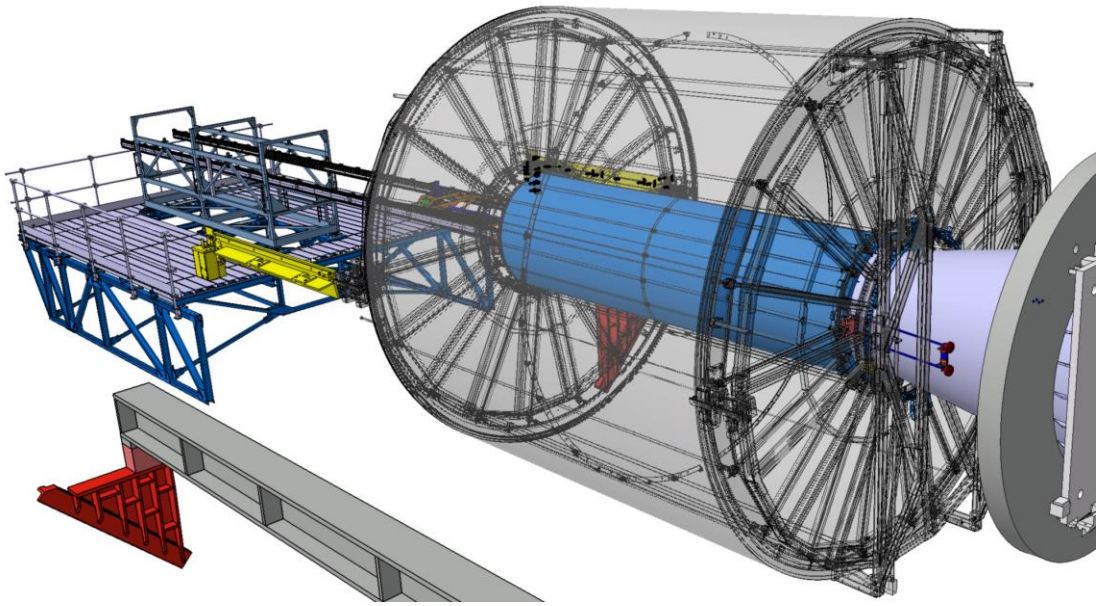
11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PWE
10.2.3	½ meter before the TPC start to engage the absorber stop the translation and dismount the temporary rails support fixed at the TPC C-side flange. Store for next use.	
10.2.4	Continue TPC translation	
10.2.5	Stop the TPC in its final position.	
11.	**Install BP Valve support and transfer BP Valve load Review procedure**	
	Transfer the BP Valve form the temporary rails to the BP Valve support	
11.1	Install BP Valve support lower part BPVS_low	
11.2	Install BP Valve support upper part BPVS_up	
11.3	Fix BP A flange on BP adjusting table	





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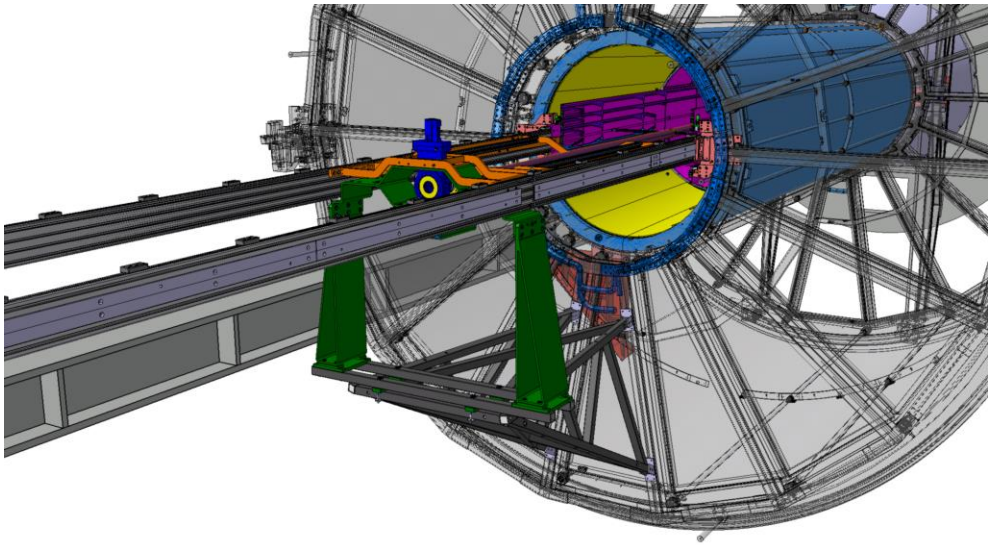
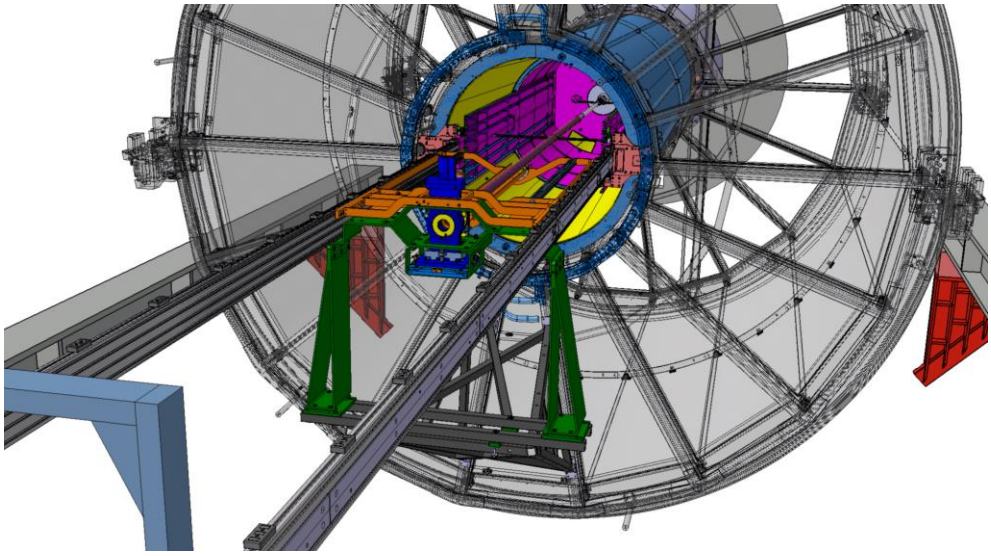
11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PWE
11.4	Fix Valve on Valve adjusting table	
11.5	Disconnect BP A flange form BP temporary support	
11.6	Disconnect BP Valve form BP temporary support	
11.7	By using micrometric adjusting tables, sitting on top of the BPVS_up transfer the load of the valve to the BP support.	





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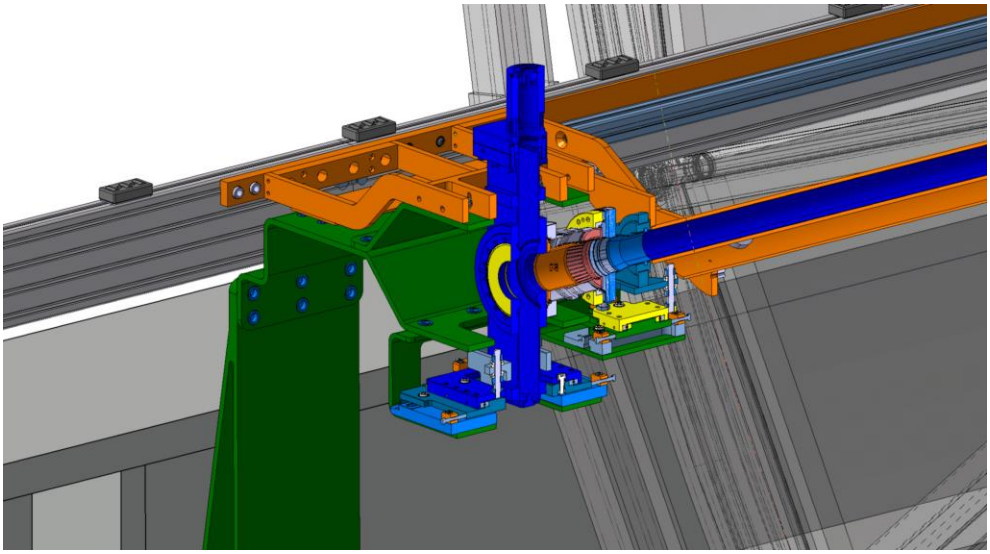


EKSMA OPTICS

OPTO-MECHANICAL COMPONENTS

OPTICAL TABLES
BRACKETS & RAILS
BASE MOUNTS & ACCESSORIES
OPTICAL MOUNTS
OPTICAL POSITIONERS
BASE POSITIONERS
TRANSLATION & ROTATION STAGES
ADJUSTMENT SCREWS

870-0040 MICROMETER SCREWS

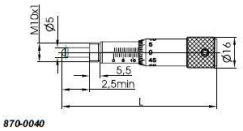
870-0040

Micrometer screws 840-0040, 840-0041 have M6x0.5 internal driving screw thread. External mounting thread – M10x1. External M10x0.5 mounting thread is available on request.
Vernier scale is engraved on a revolving cylindrical collar of the micrometer screw. The collar can be rotated to make the scale visible if micrometer screw is mounted with the scale out of sight.
870-0040, 870-0041 are used in translation stages and mirror mounts and can be used in mounts and stages of other manufacturers.

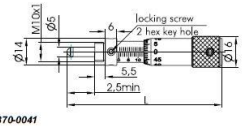
- Designed for micro-positioning applications
- Stainless steel screw with hardened steel ball tip
- Brass threaded collar
- Very smooth motion allows positioning with sensitivity of 1 µm
- Scale 10 µm division
- Nominal travel 5, 10, 15, 20, 25, 30, 50 mm

SPECIFICATIONS

Scale graduation	0.01 mm
Sensitivity	1 µm
Pitch	M6×0.5
Thread	M10×1
(as option)	M10×0.5



870-0040



870-0041

Code	Nominal travel, mm	Maximum travel, mm	L, mm	Weight, kg	Price, EUR
870-0040-05, 870-0041-05	5	7	40	0.03	47 / 65
870-0040-10, 870-0041-10	10	13	54	0.04	51 / 69
870-0040-15, 870-0041-15	15	17	60	0.04	55 / 73
870-0040-20, 870-0041-20	20	22	70	0.05	60 / 78
870-0040-25, 870-0041-25	25	27	81	0.06	66 / 84
870-0040-30, 870-0041-30	30	32	92	0.08	79 / 97
870-0040-50, 870-0041-50	50	52	136	0.10	100 / 118

860-0058-20
with 870-0040-20 installed

860-0060-06
with 870-0040-50 installed

860-0053 XYZ
with 870-0040-25 installed

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12. Tranfer Cage load to the TPC

12.1 Fix the cage position in z by engaging the side lockers on Aside

12.2 Move down Cage feet of the adjusting device by applying a torque at the extremities of the Adjusting Devices interface CADJ. Use a calibrated torque wrench. The torque value should never surpass 1.5Nm on any Adjusting Device.

12.2.1 Lift the Cage 1 mm from the Temporary Rails to allow the Temporary Rails extraction. This will induce a bending load on the Beam Pipe that it is deemed to be negligible.

12.2.2 Dismount temporary rails sections at the table. Disengage C-side….

12.2.3 Slide out Temporary Rails from TPC.

12.2.4 Store Temporary Rails for next use.

12.2.5 Torque the 6 vertical CADJ to the final nominal values. Rather than torque, I would take as a reference the number of turns from the lowest position and then adjust with the survey

Torque wrench S/N#:_____ and due date_____.

Record the torques here:

AD_IF#	Applied	(Nominal)	Applied	(Nominal)
C1V-I-side	_____	(___Nm)	C1V-O-side	_____(___Nm)
C2V-I-side	_____	(___Nm)	C2V-O-side	_____(___Nm)
C3V-I-side	_____	(___Nm)	C3V-O-side	_____(___Nm)

12.3 Lock the side fingers of the lateral Adjusting devices by torqueing them

12.3.1 Torque the 4 lateral ADIF to the final nominal values

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	Torque wrench S/N#:_____ and due date_____. Record the torques here: AD_IF# Applied (Nominal) Applied (Nominal) C1L-I-side_____ (___Nm) C1L-O-side_____(___Nm) C3L-I-side_____ (___Nm) C3L-O-side_____(___Nm)	
12.3.2	Verify that the Cage Z-stop is engaged (C1L-I and O side) Update pictures	

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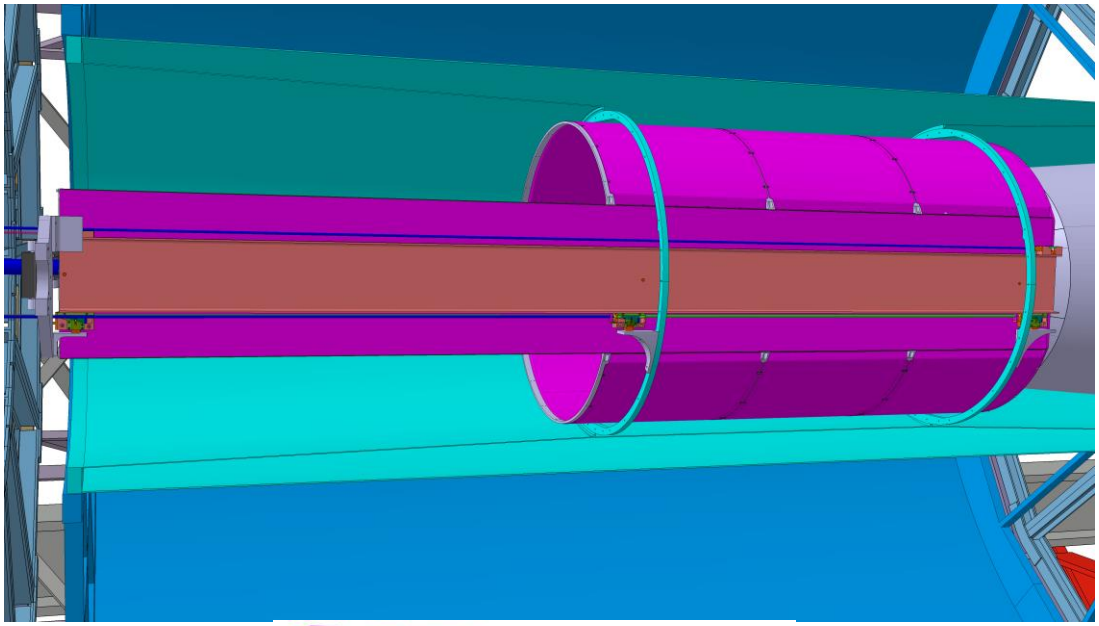

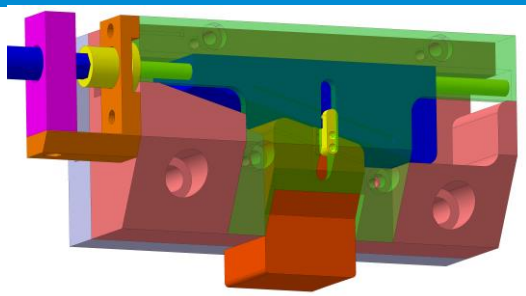

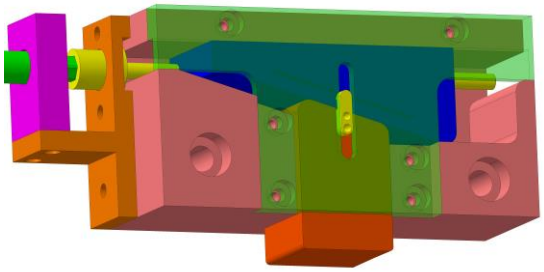

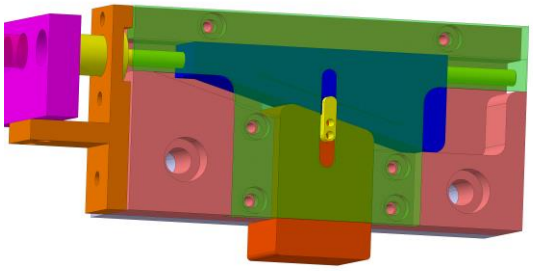

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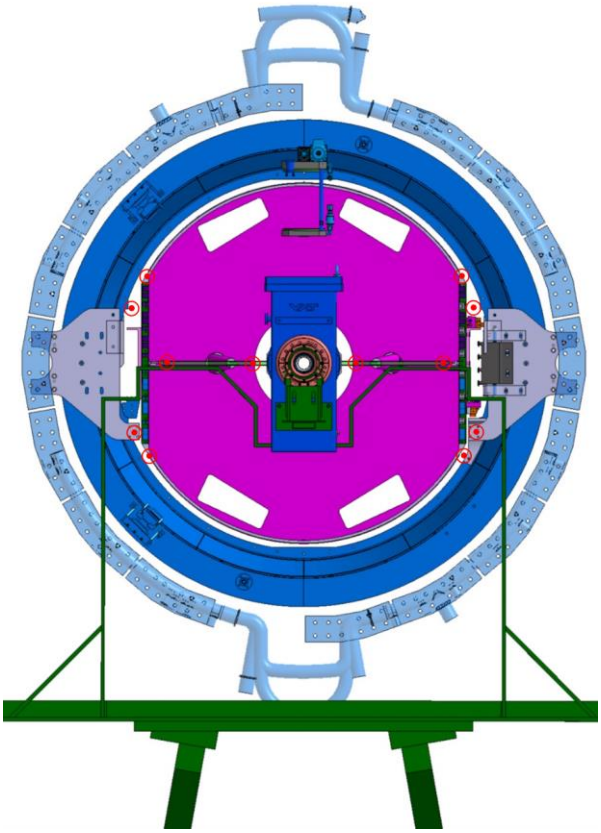
11. OPER SEQ. NO.	12. OPERATIONS (Print, Type, or Write Legibly)	13. NOTE QA/PWE

13. Adjust the Cage and beampipe

13.1 Survey the position of the Cage/BP with respect to the beam line. Update picture



13.2 Align the beampipe to the beamline by acting on the C_ADJ and on the BPV_ADJ.

13.3 Freeze the position of the BP by installing the final fixation screws and by removing the BPV_ADJ micrometric table.

14. Close this ATS