

Staged approach of Barrel EMC integration: study of the only possible design

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GSI

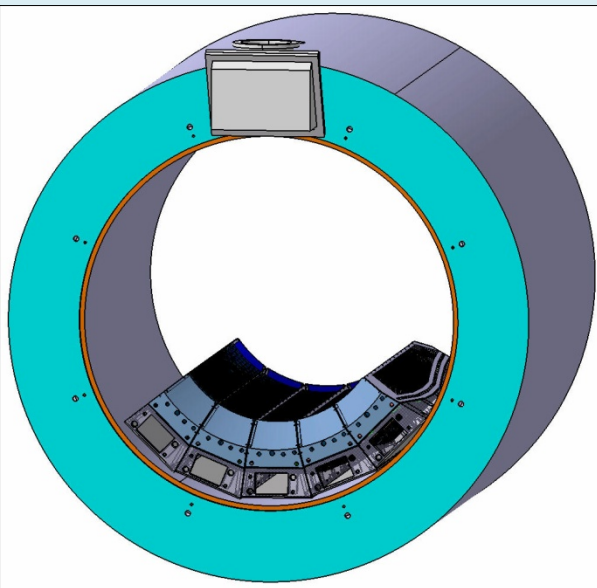


The main goal of this Report is to choose the only possible design of Barrel mechanics.
To do it we studied two scenarios of Barrel assembly:

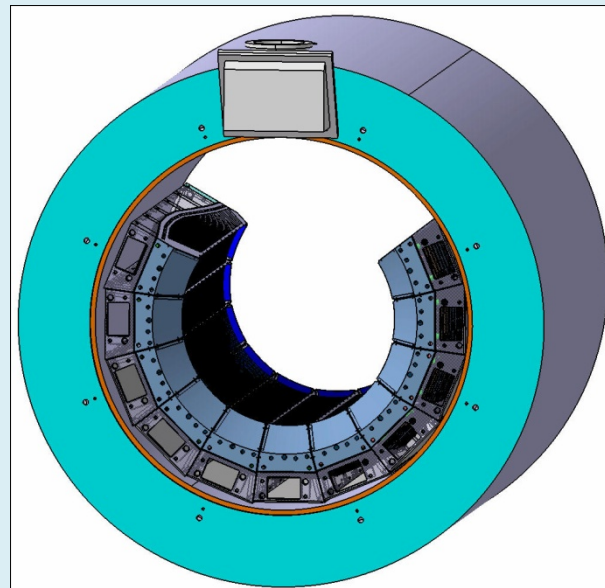
- the Main version (described in TDR and Technical Specifications).
- five different versions of Modular approaches.

1. Why Modular approach?

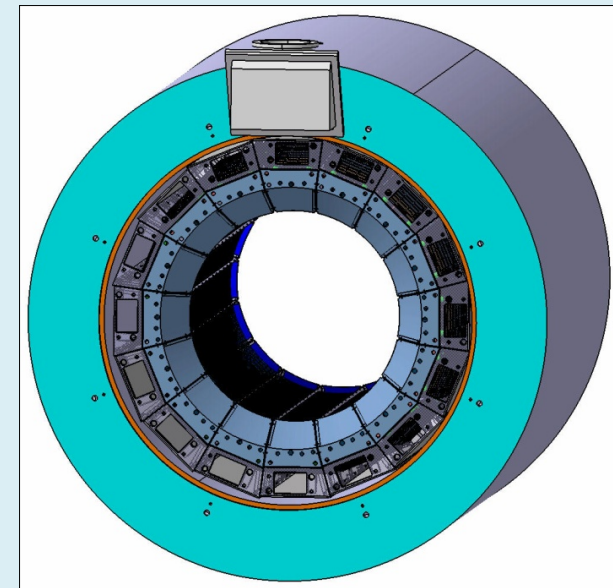
- Not all crystals can be produced in time;
- Modular approach would allow one to assemble Barrel EMC in few stages with minimum disassembling of PANDA setup between experimental runs.



Stage N1



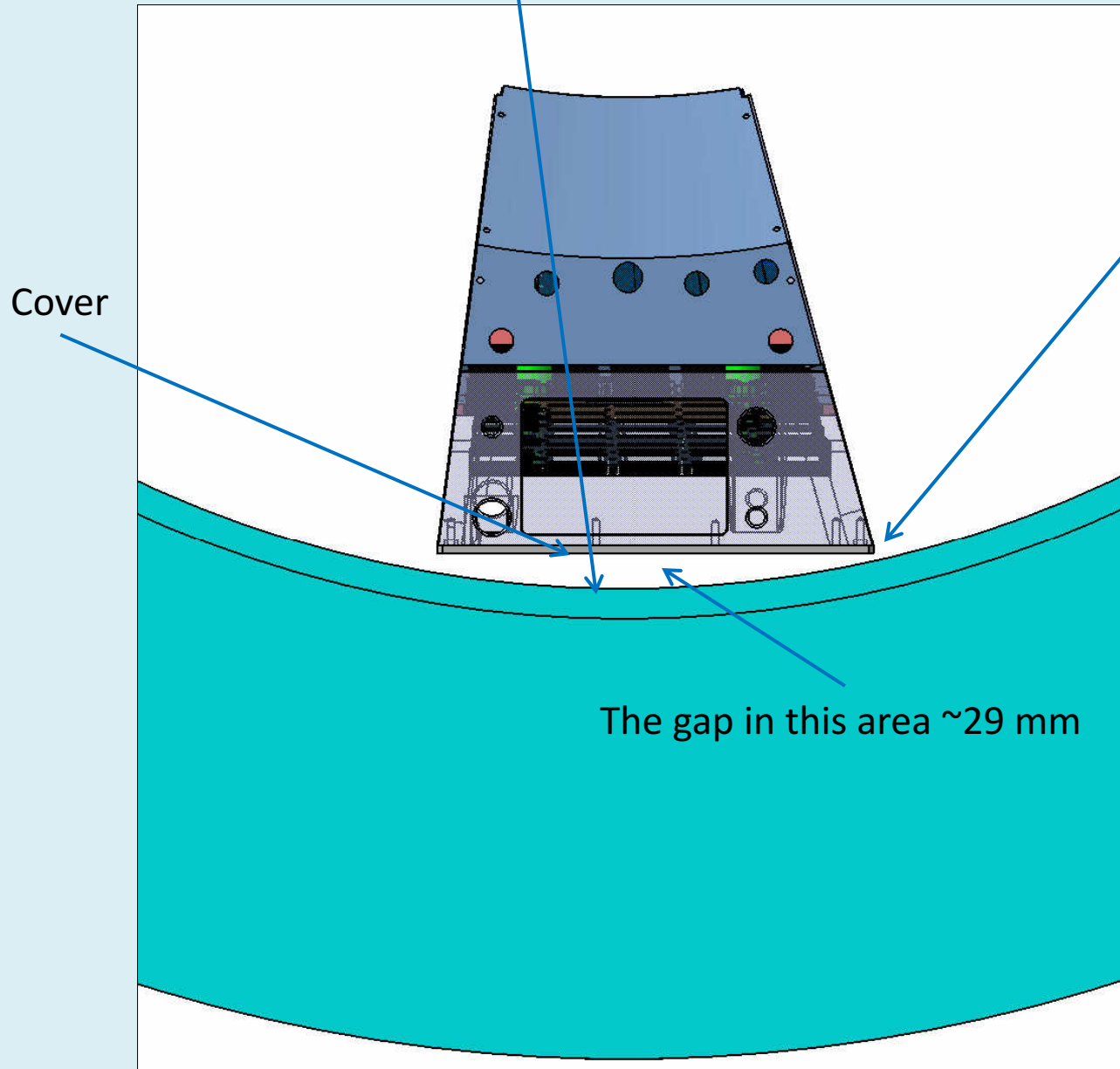
Stage N2



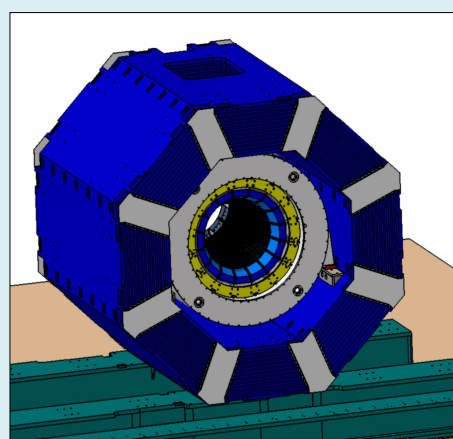
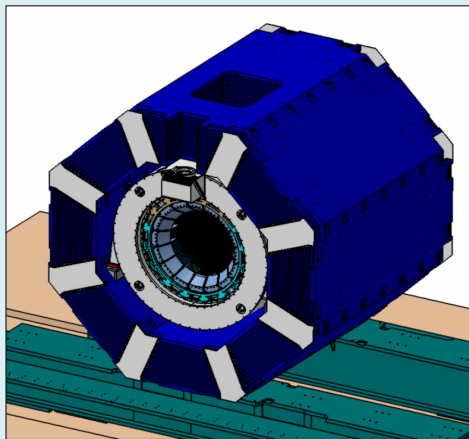
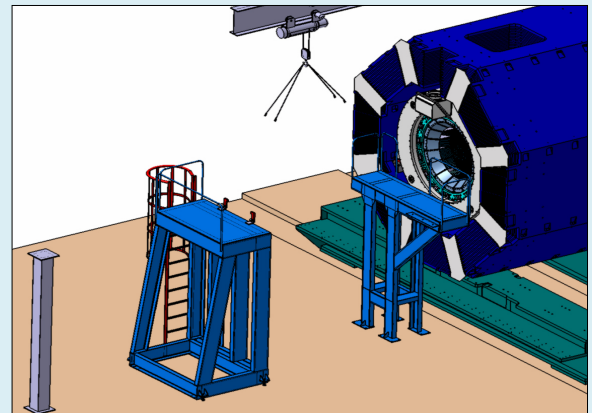
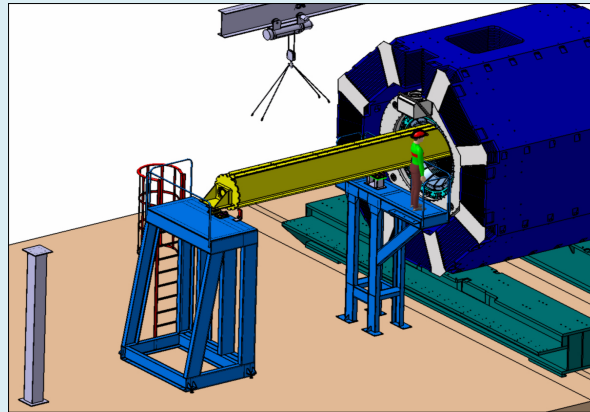
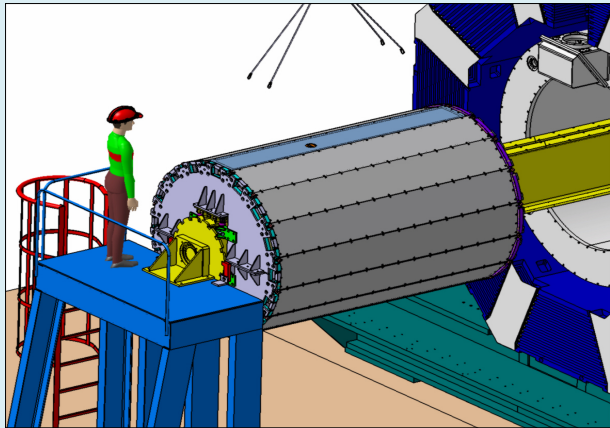
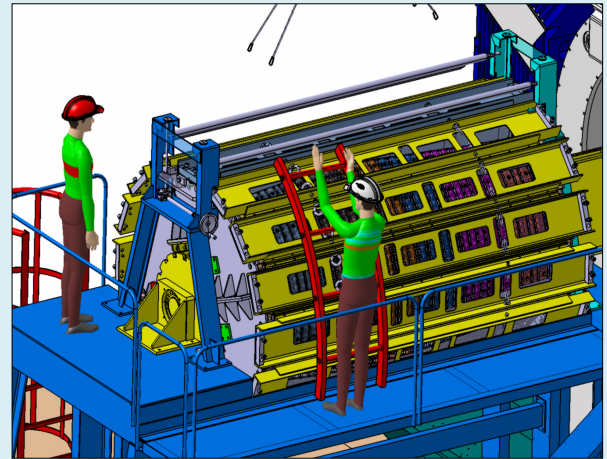
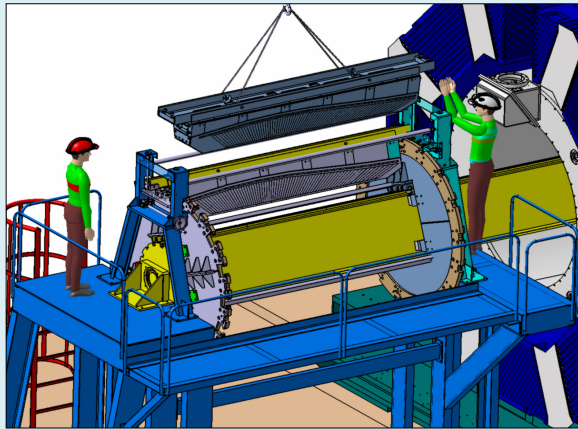
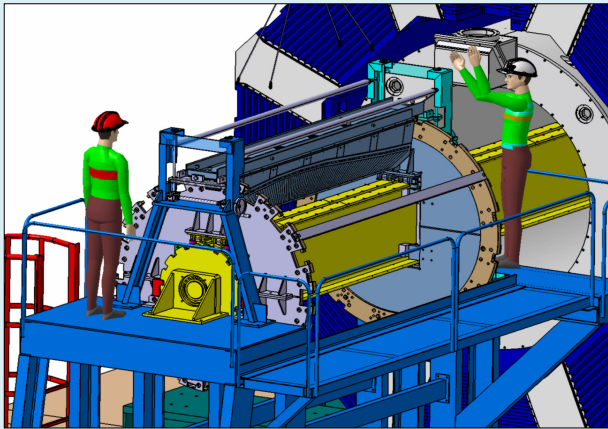
Stage N3

2. Boundary conditions

The minimal gap between inner surface of cryostat and a cover of the slice is only 6 mm

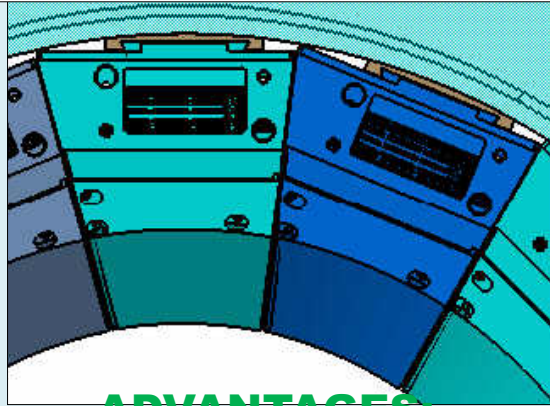
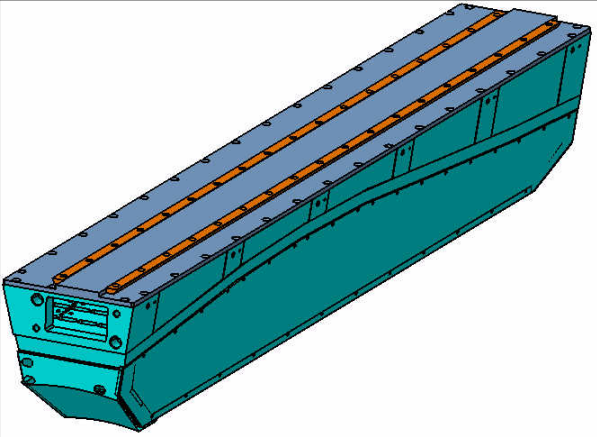


3. Short explication of Main Version



4. COMPARATIVE ANALYSIS OF 5 ALTERNATIVE (MODULAR) VERSIONS

Modular Version N1



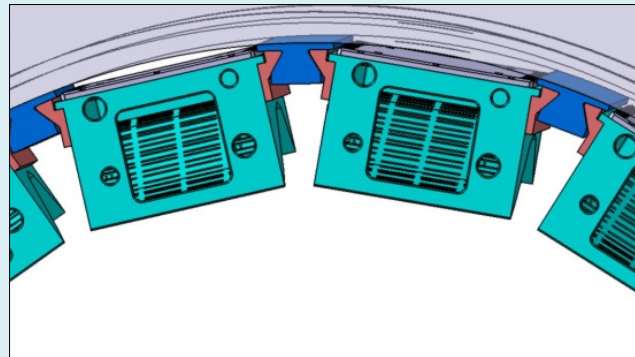
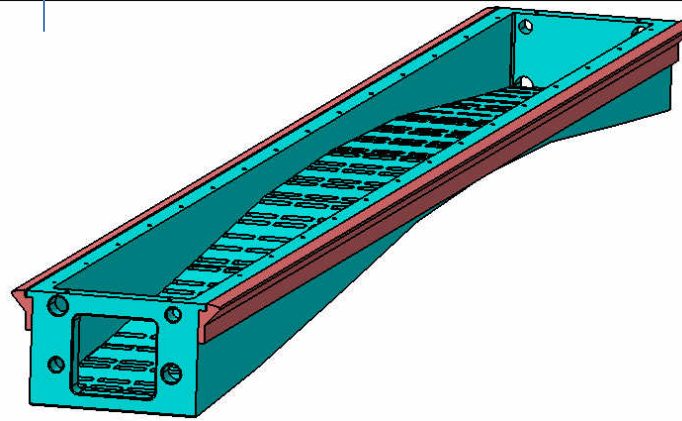
ADVANTAGES:

1. More space for the Cables, Services.

DISADVANTAGES:

1. More requirements to stiffness for the Cover.
2. Insufficient space for Rails installation- the Version does NOT fit

Modular Version N2



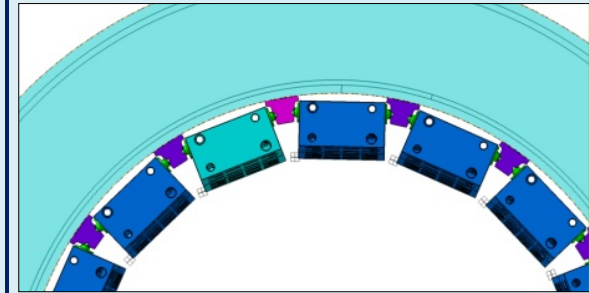
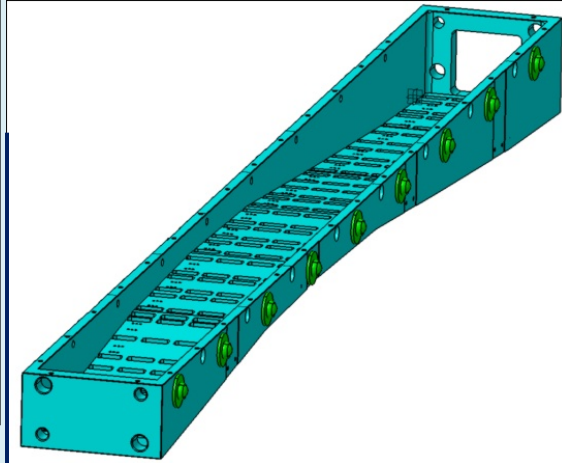
ADVANTAGES:

1. More stiffness.
(Rails on the Beam)

DISADVANTAGES:

1. Less space for the Cables, Services- the Version does NOT fit

Modular Version N3



ADVANTAGES:

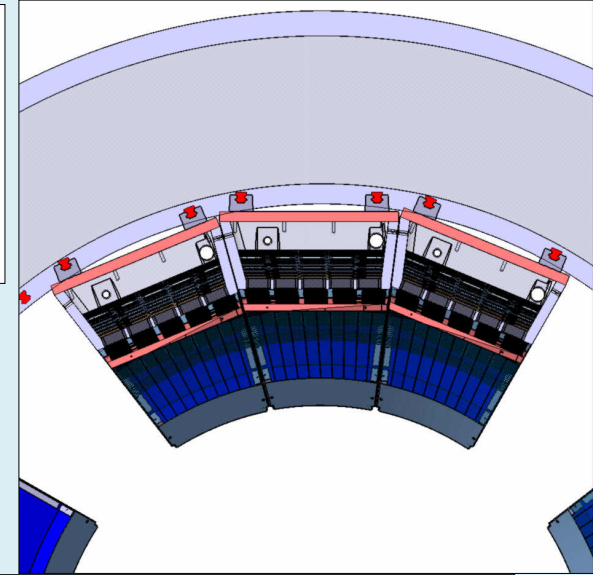
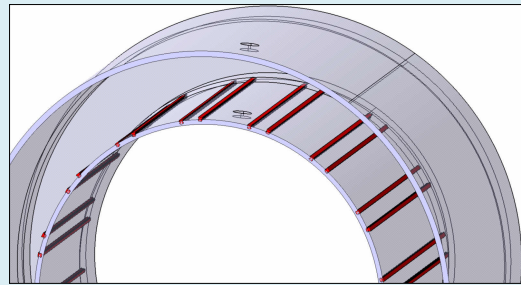
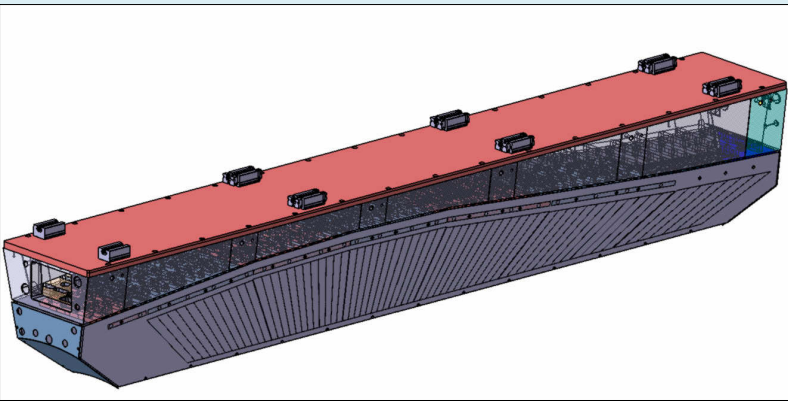
1. More stiffness.
(Ball Transfer Units on the Beam)

DISADVANTAGES:

1. Less space for the Cables, Services- the Version does NOT fit

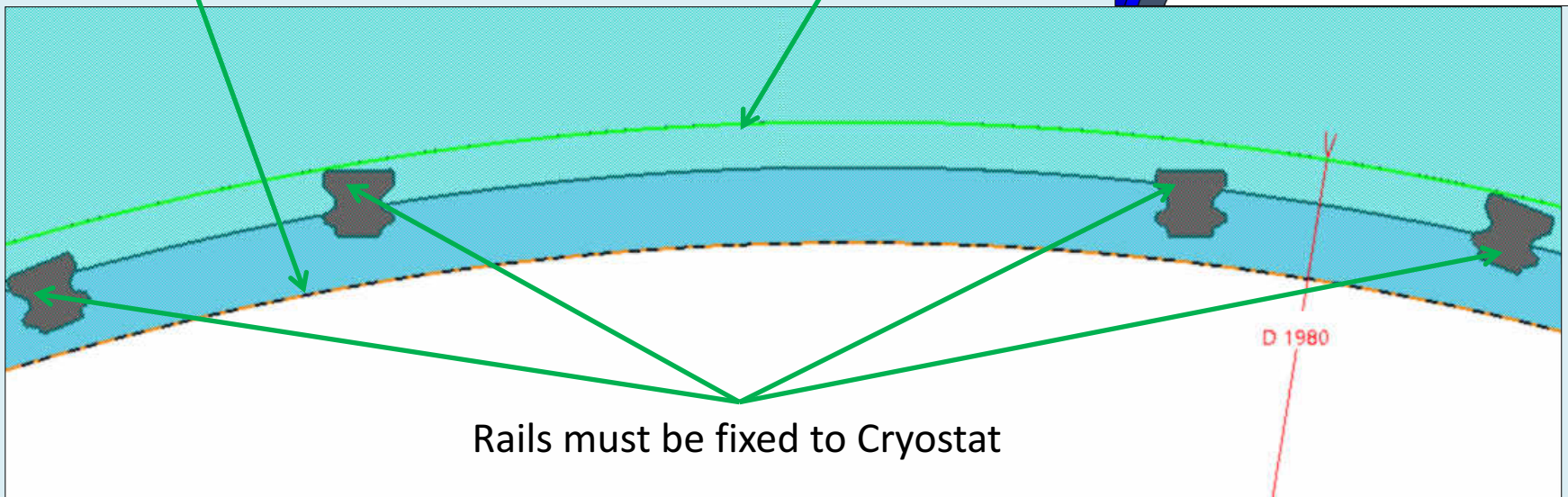
COMPARATIVE ANALYSIS OF 5 ALTERNATIVE (MODULAR) VERSIONS (continue)

Modular Version N4

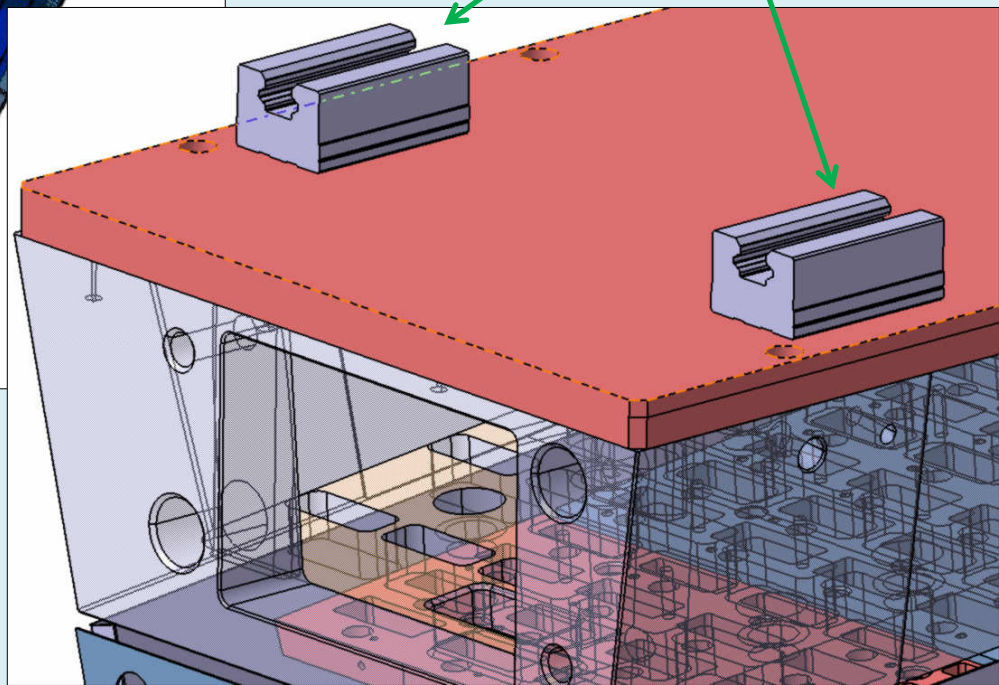
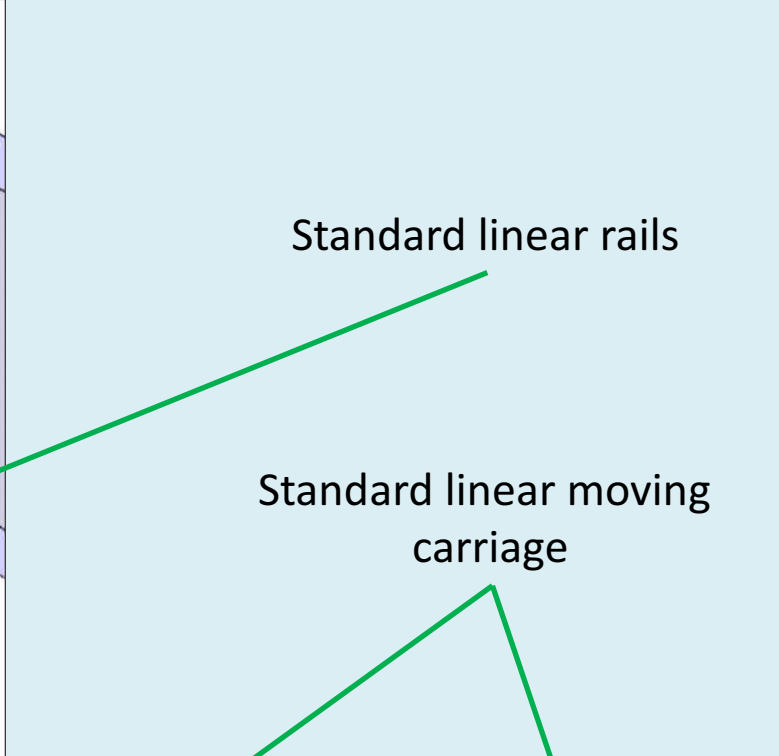
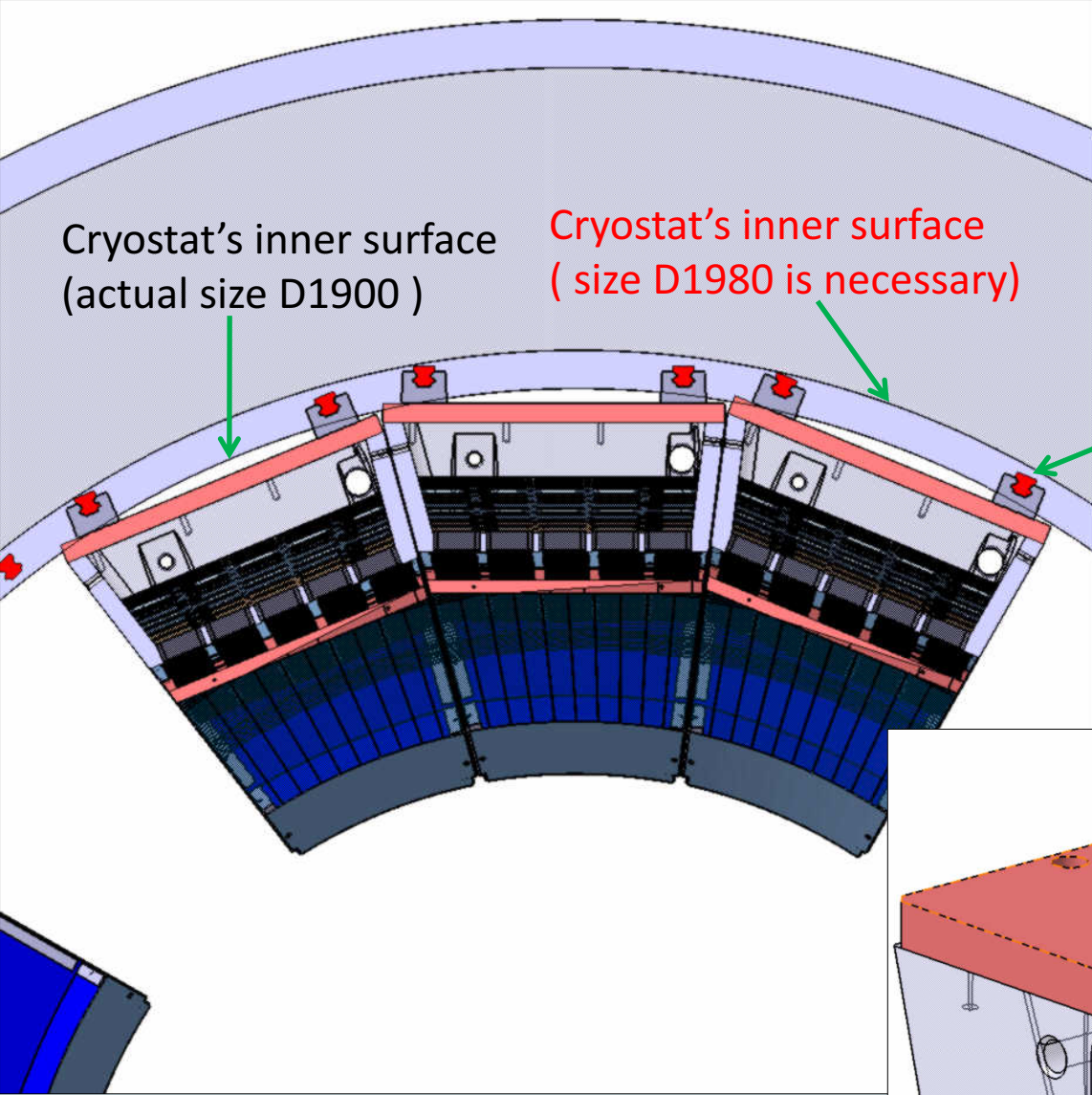


Cryostat's inner surface
(actual size D1900)

Cryostat's inner surface
(size D1980 is necessary)



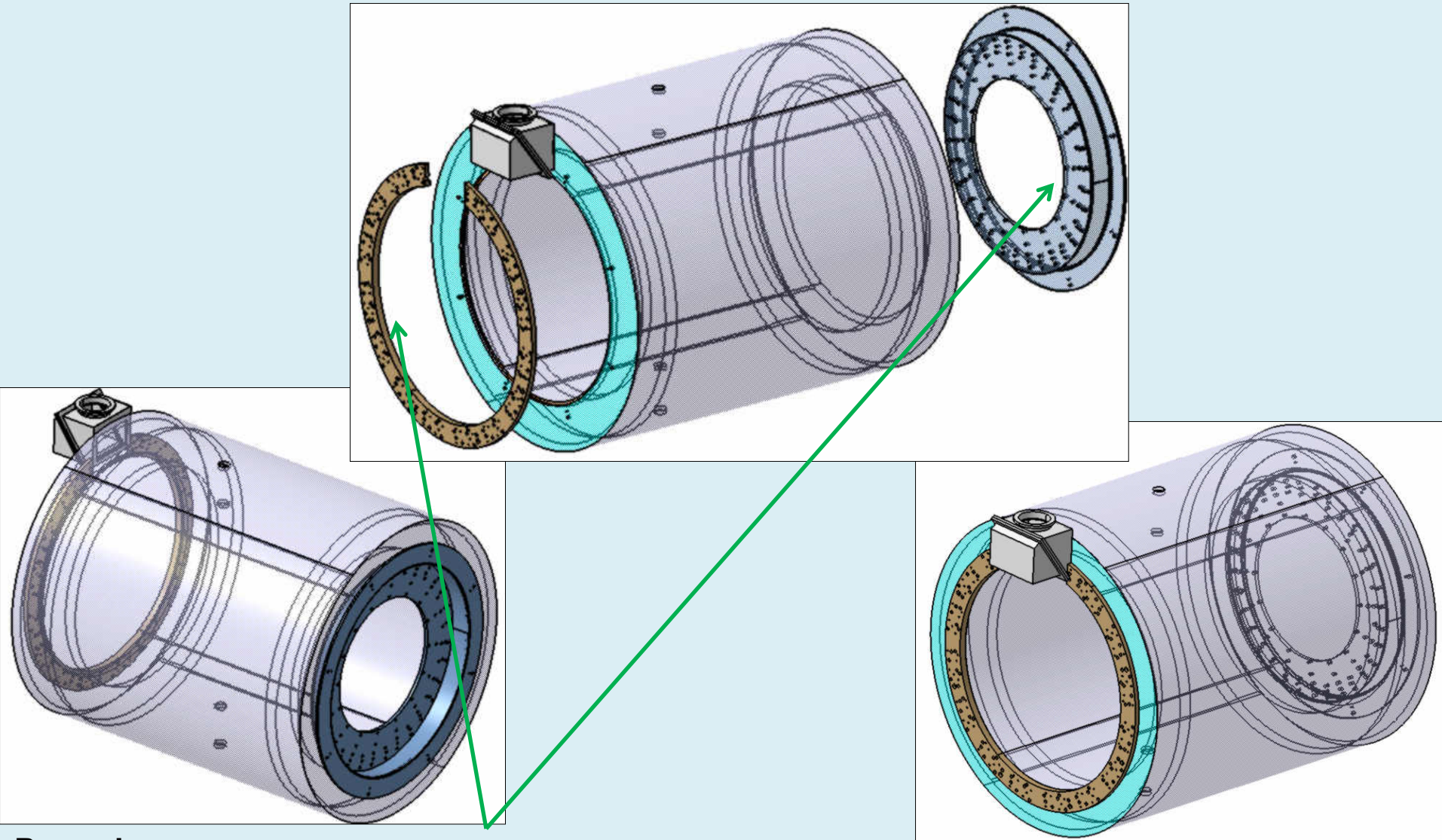
**Conclusion- this version does NOT fit without enlargement
of inner diameter of Cryostat**



COMPARATIVE ANALYSIS OF 5 ALTERNATIVE (MODULAR) VERSIONS (continue)

VERSIONS N5 (more realistic)

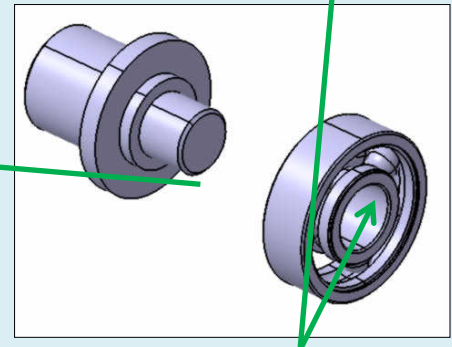
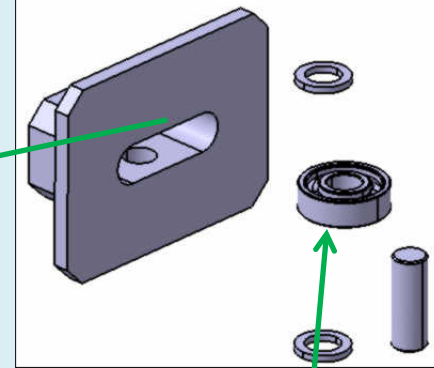
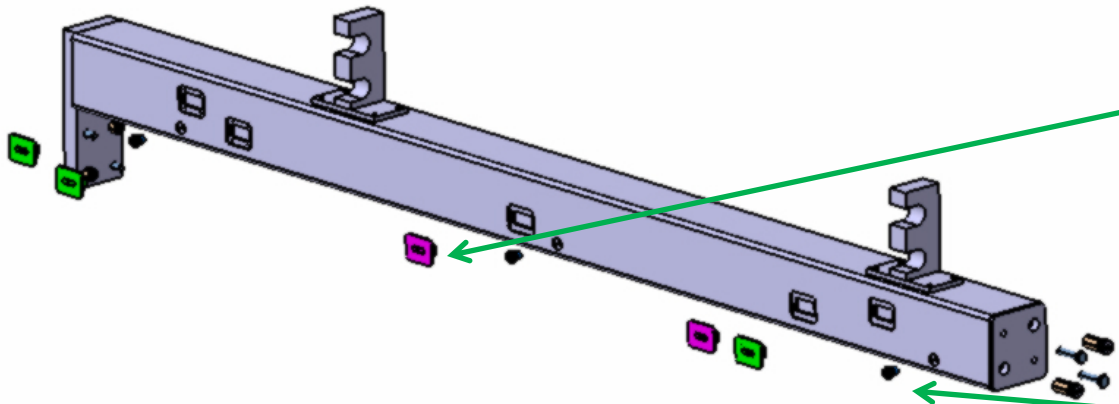
STEP 1- Cryostat preparation (Magnet is not shown)



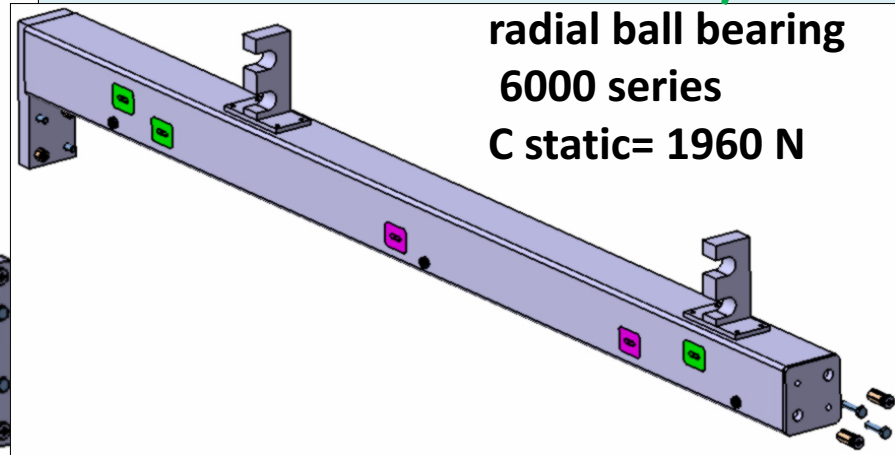
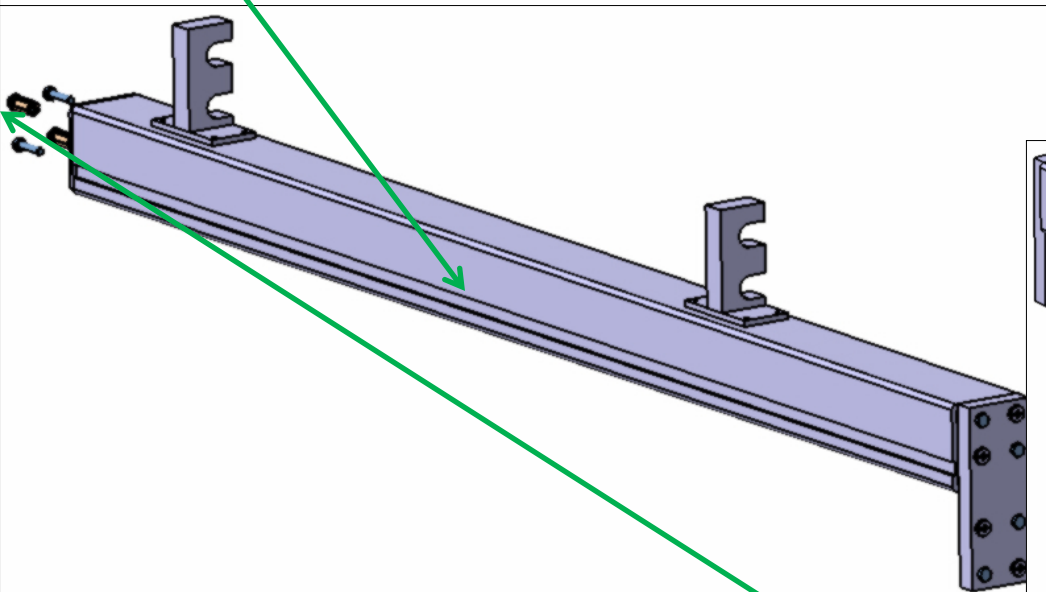
Procedures:

- Mounting and fixation of 2 Rings from both sides to the Cryostat;
(Upstream side ring has an incision. In this case it has a reduced stiffness)

STEP 2- Preparation of 2 special technological beams



Precise slot for bearings moving have to be machined

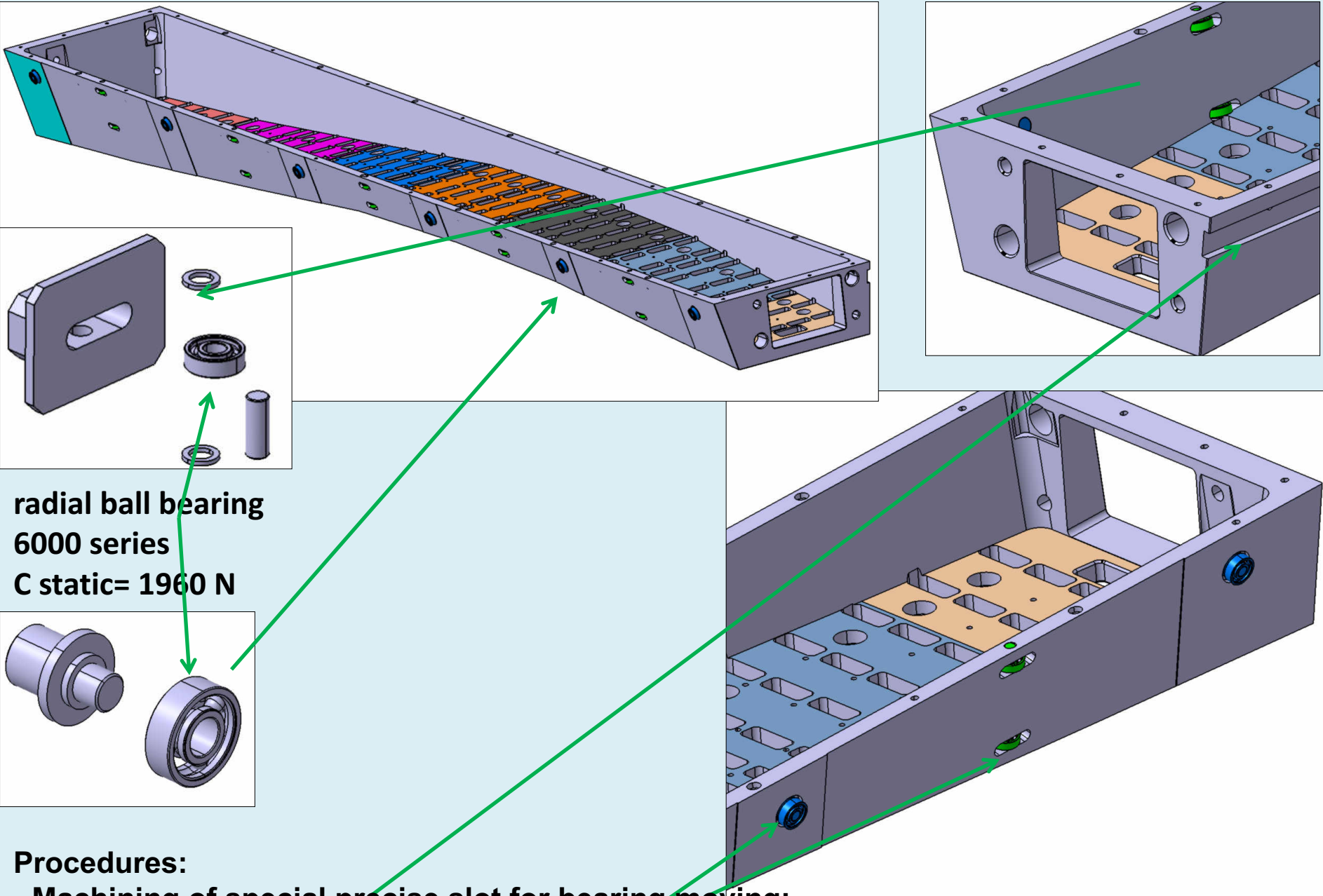


radial ball bearing
6000 series
C static= 1960 N

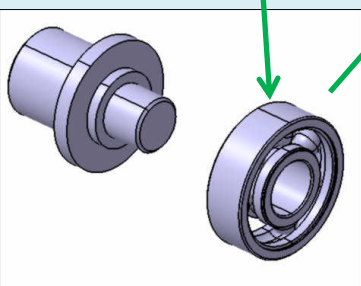
Procedures:

- Mounting and fixation of 4 centering pins and 4 bolts M16 and 5 bearing assemblies on technological beam (black steel square tube 160x160x12 mm);

STEP 3- Support beam preparation (simplified view)



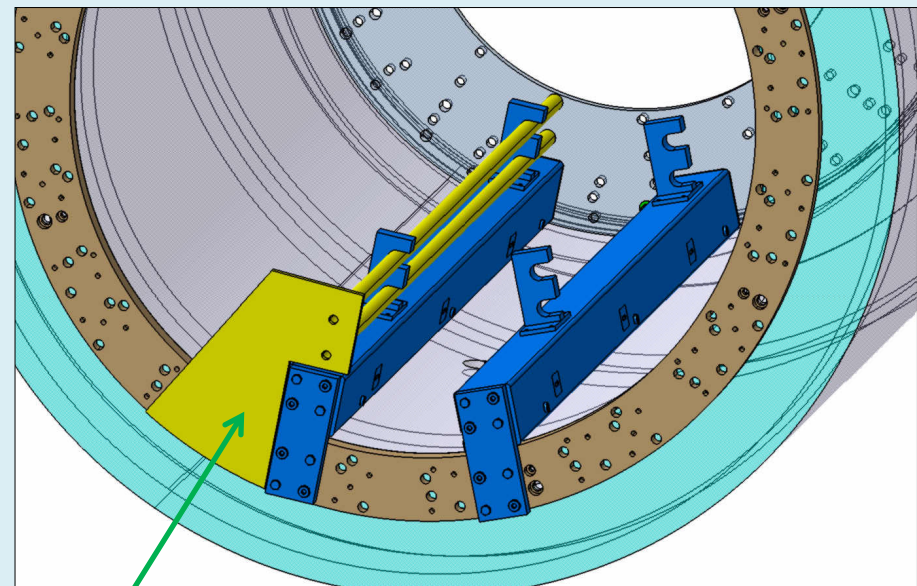
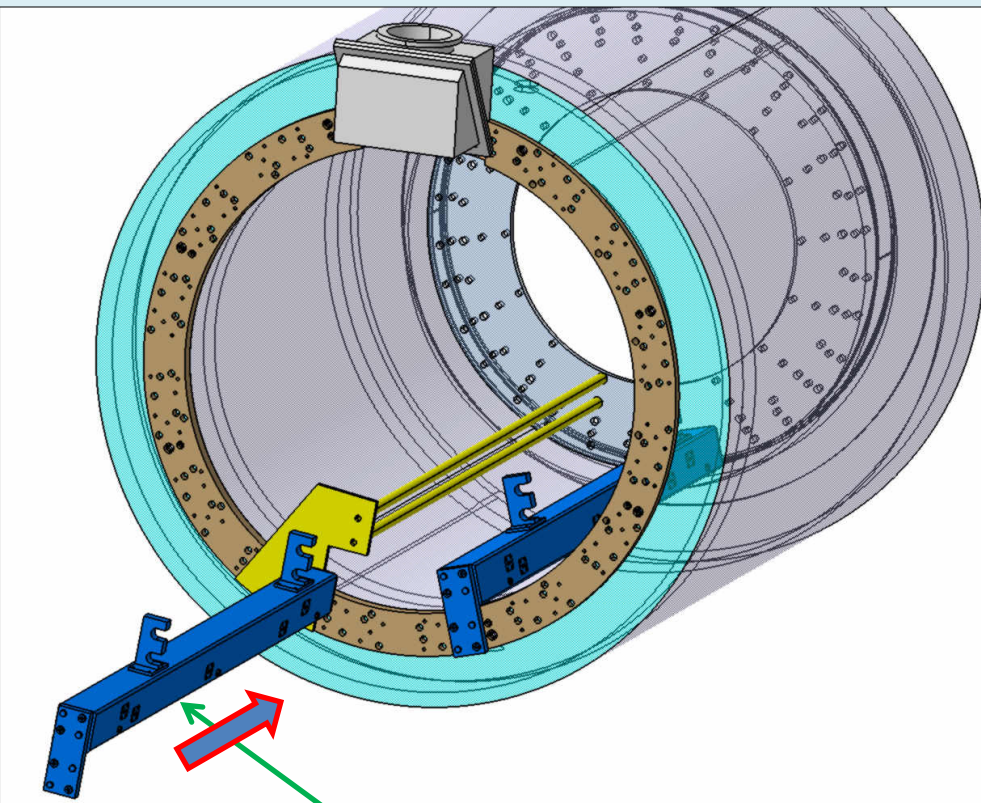
radial ball bearing
6000 series
C static= 1960 N



Procedures:

- Machining of special precise slot for bearing moving;
- Mounting and fixation of 16 bearing Assemblies on the support beam.

STEP 4- Technological Beams installation (Magnet is not shown)

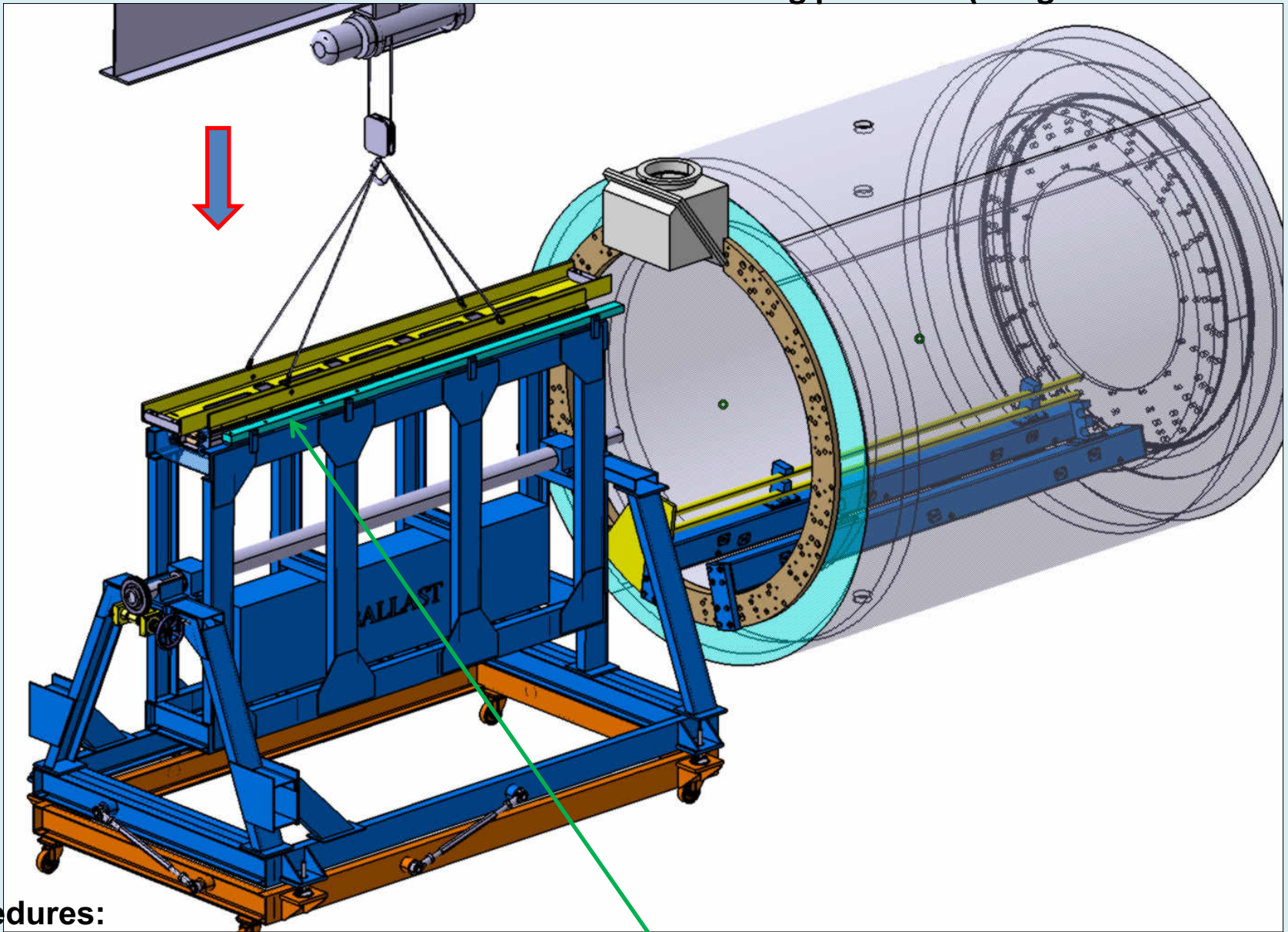


because of the high weight of the technological Beams (~180 kg) it is necessary to use special guide for technological beams installation

Procedures:

- Mounting and fixation of guide (yellow on the picture) ;
- Pushing and sliding technological beam along the guide;
- Mounting and fixation of technological beam by means of 2 centering pins and 2 bolts from downstream and upstream sides.

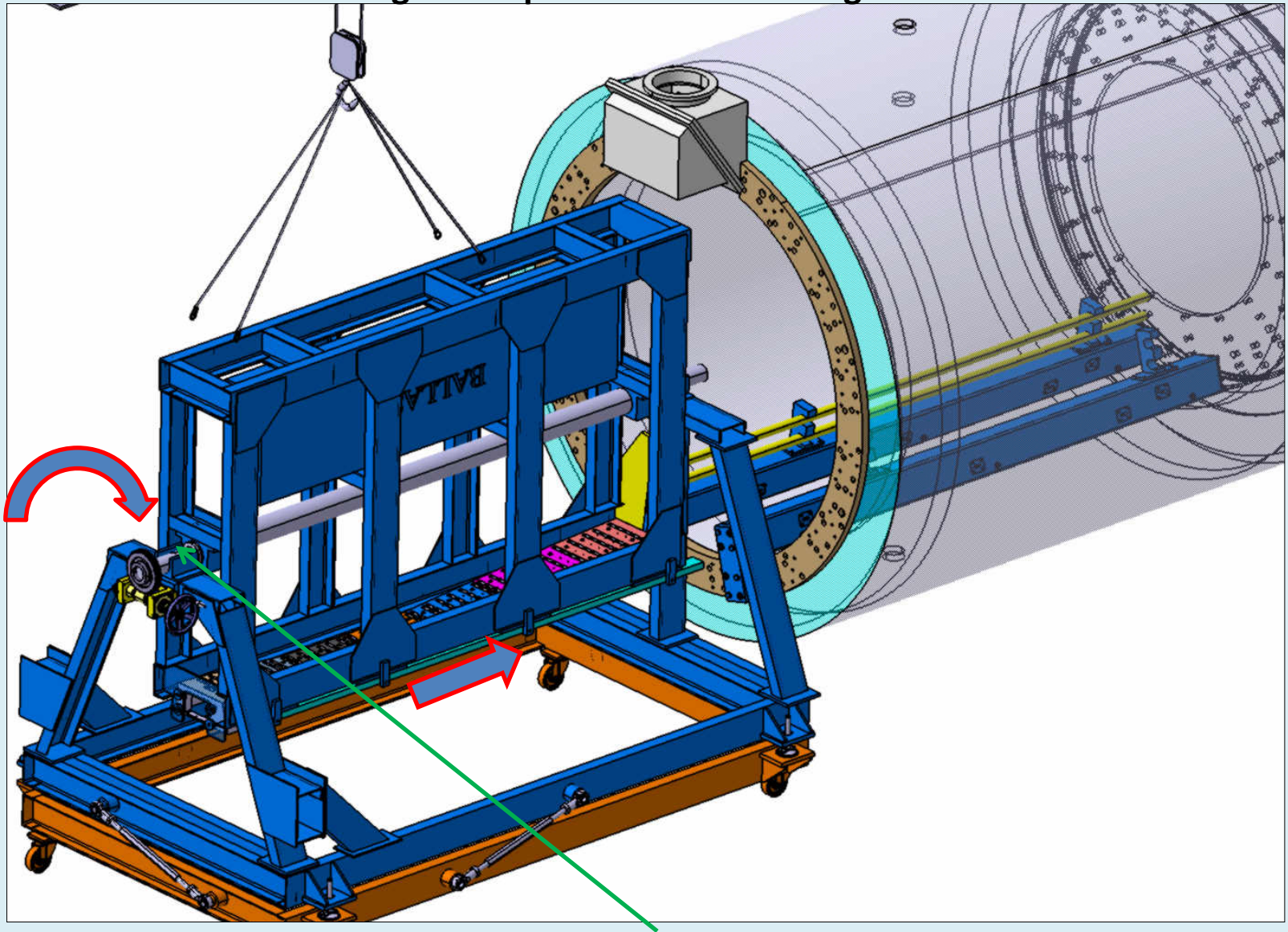
**STEP 5- Installation of the tilting device (cantilever) in the preliminary position.
Installation and attachment of the slice to the rotating platform. (Magnet is not shown)**



Procedures:

- The slice to be installed on the rotating platform of the cantilever;
- Adjusting of the slice and installation of special guide rails to fix the slice on the platform.

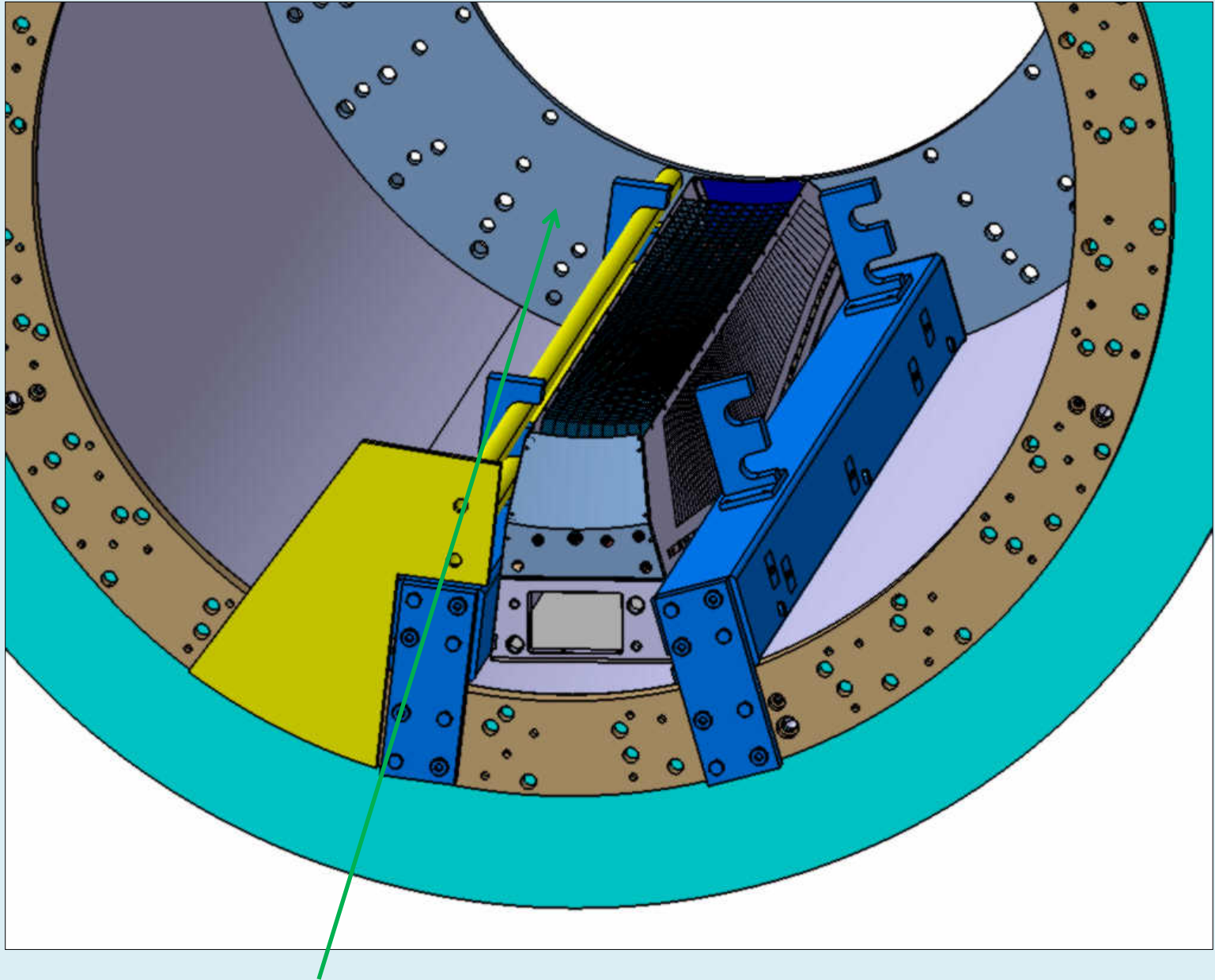
STEP 6- Rotating and adjusting of technological device according to the position of technological beams



Procedures:

- Rotating of technological device by means of transfer worm;
- Adjusting of the tilting according to position of technological beams;

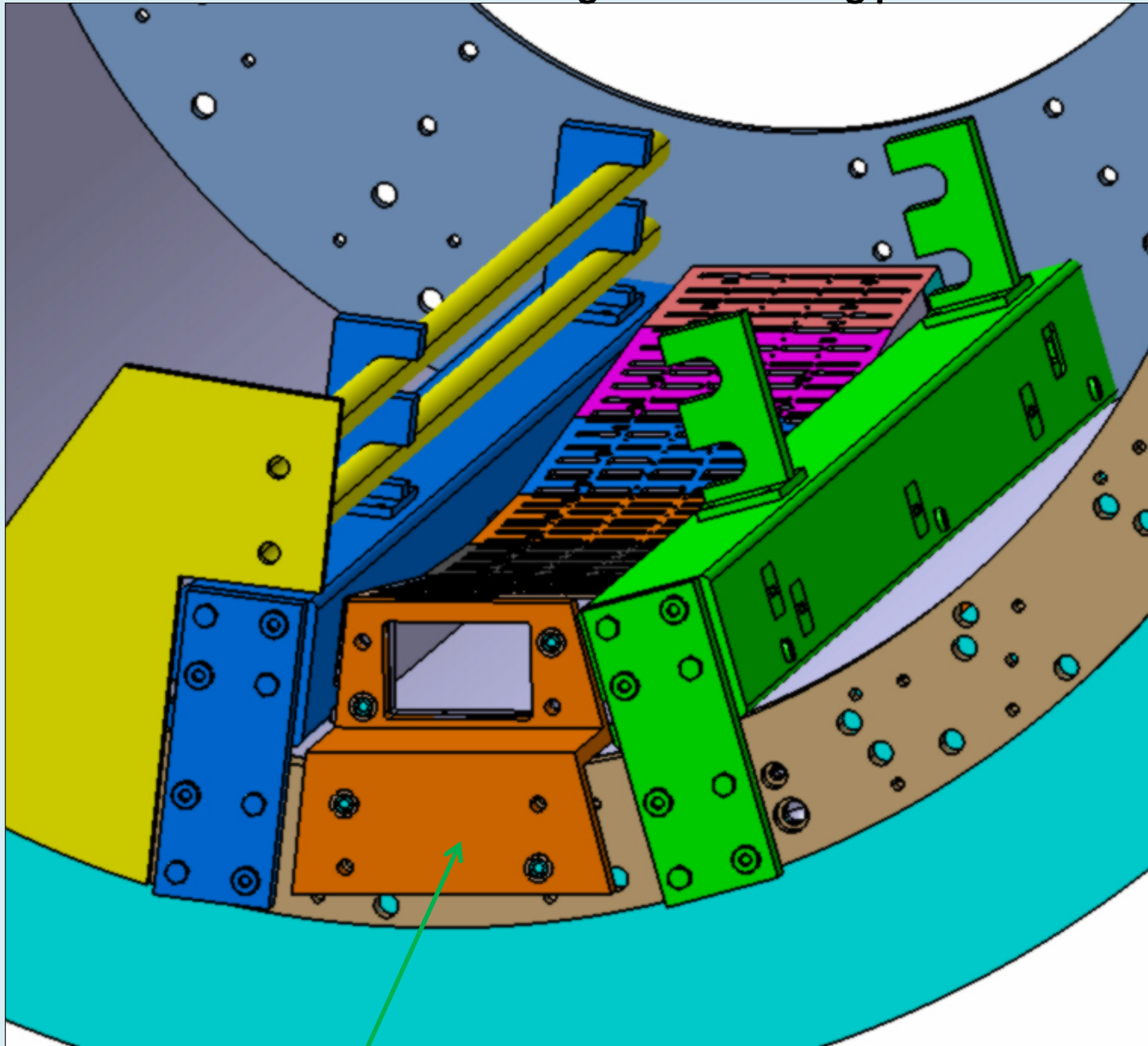
STEP 7- Rolling in of Slice to the working position



Procedures:

- Slice to be rolled in till the stop on the flange;

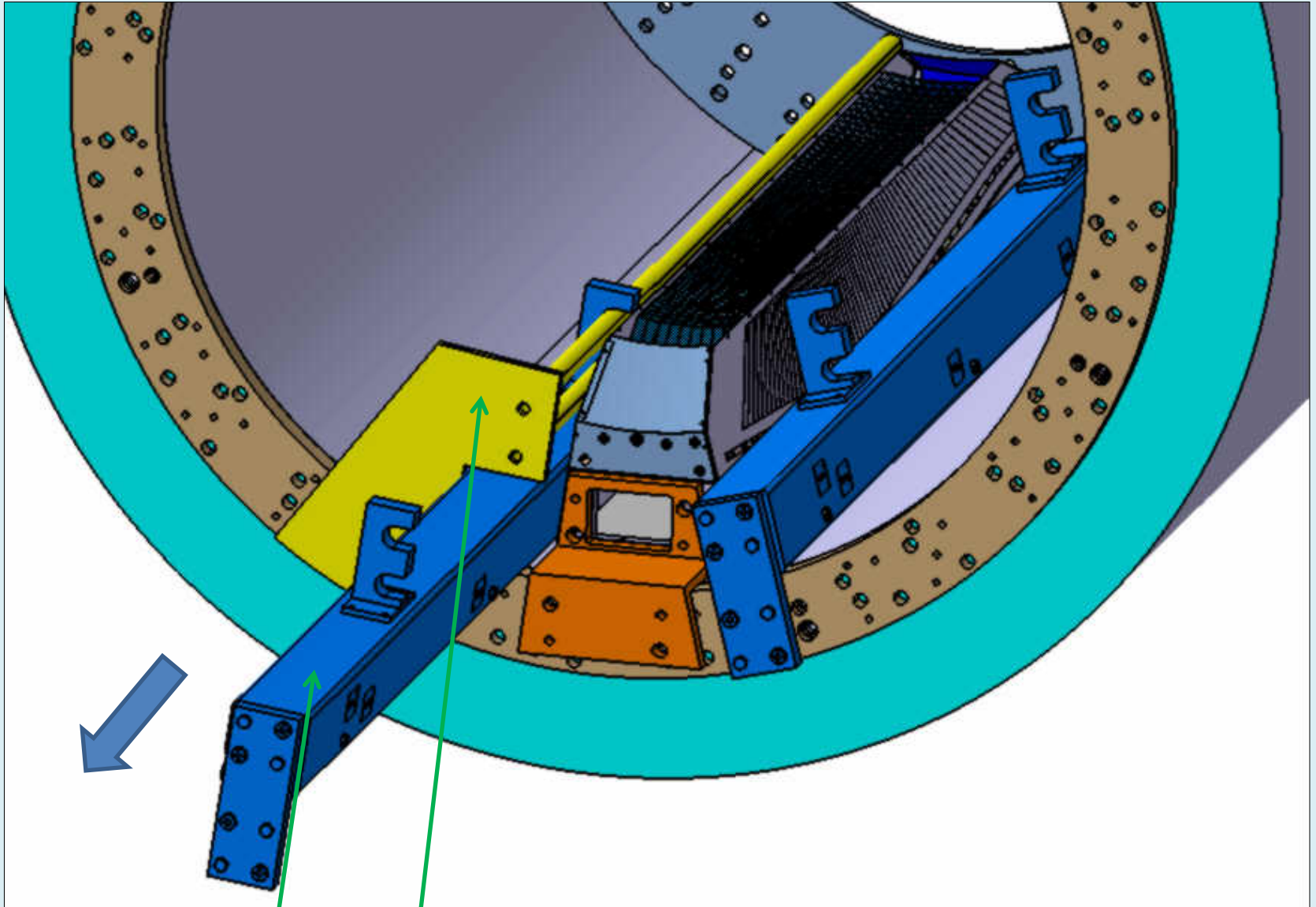
STEP 8- Slice mounting at the working position



Procedures:

- Slice to be fixed to the downstream ring with the use of 2 centering pins and 2 bolts M16 and by the bracket from upstream side.

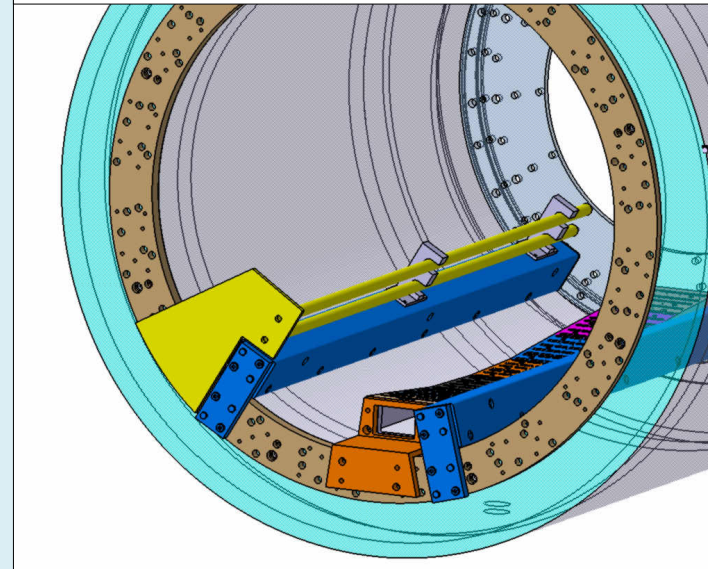
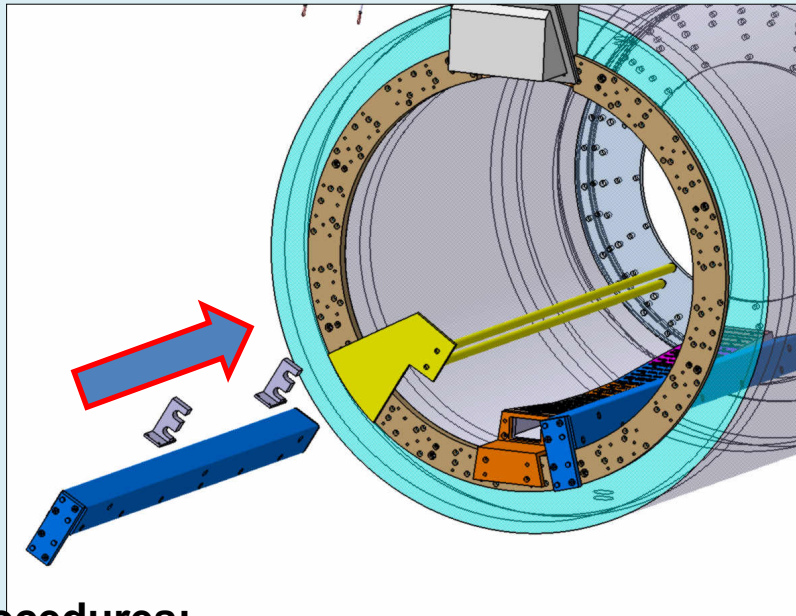
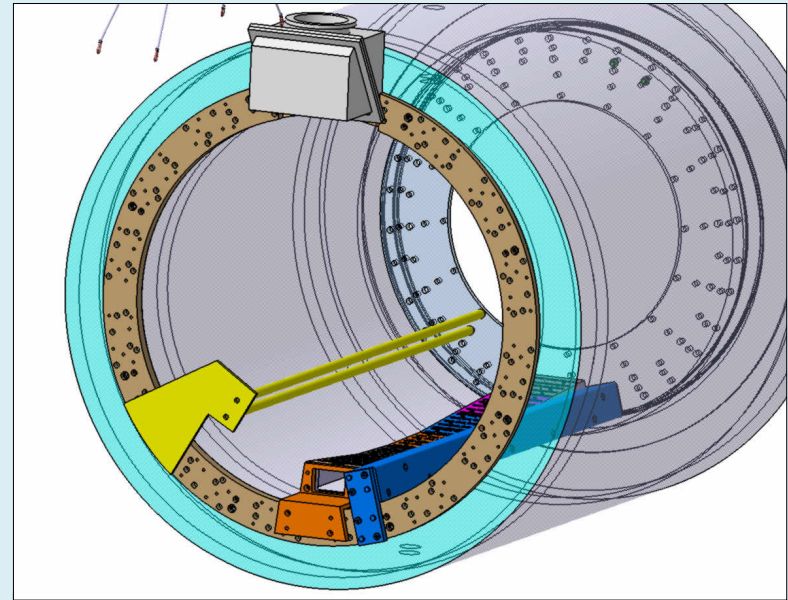
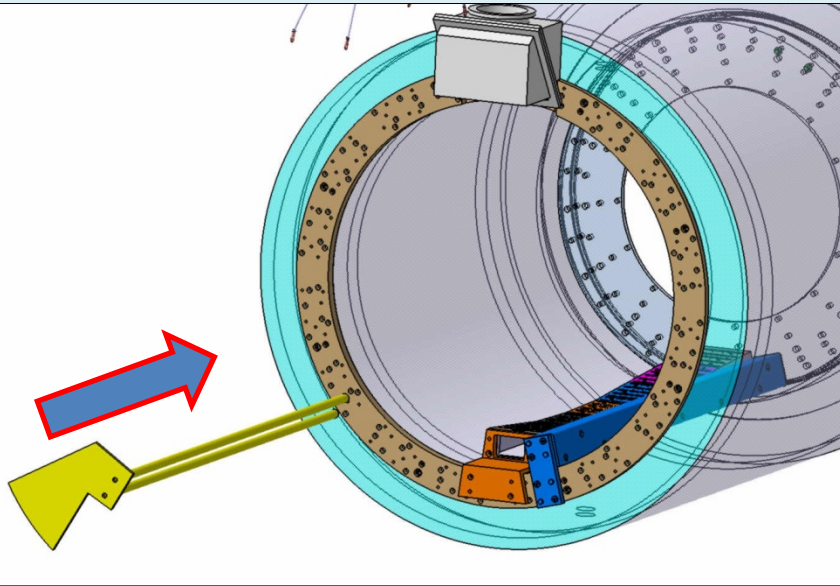
STEP 9- Dismounting of the technological bracket



Procedures:

- Removal of the left technological beam (blue color);
- Removal of the guide (Yellow color).

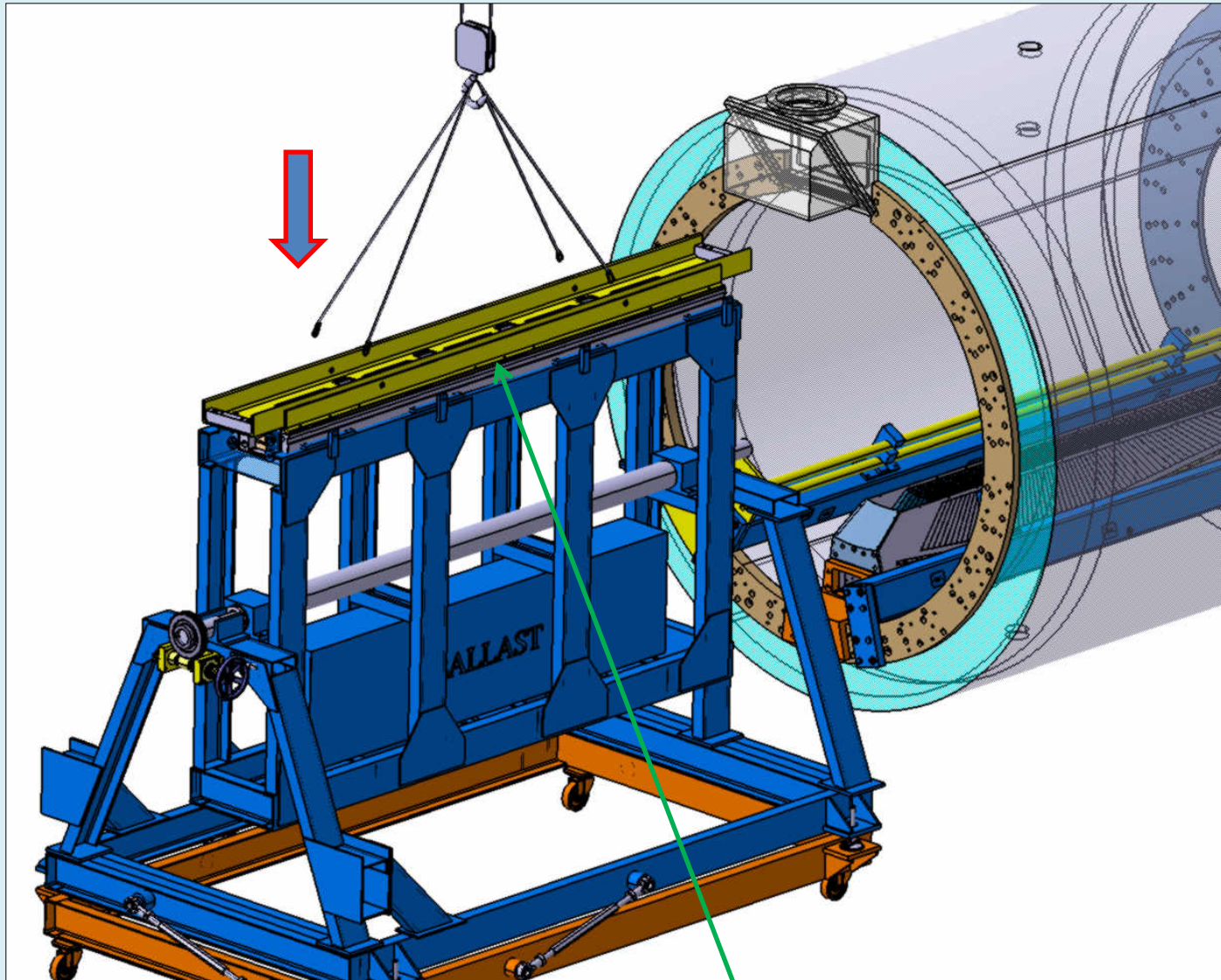
STEP 10- Installation of the technological beam in the next position



Procedures:

- Installation of the guide (yellow color) in new position;
- Installation of the technological beam in new position.

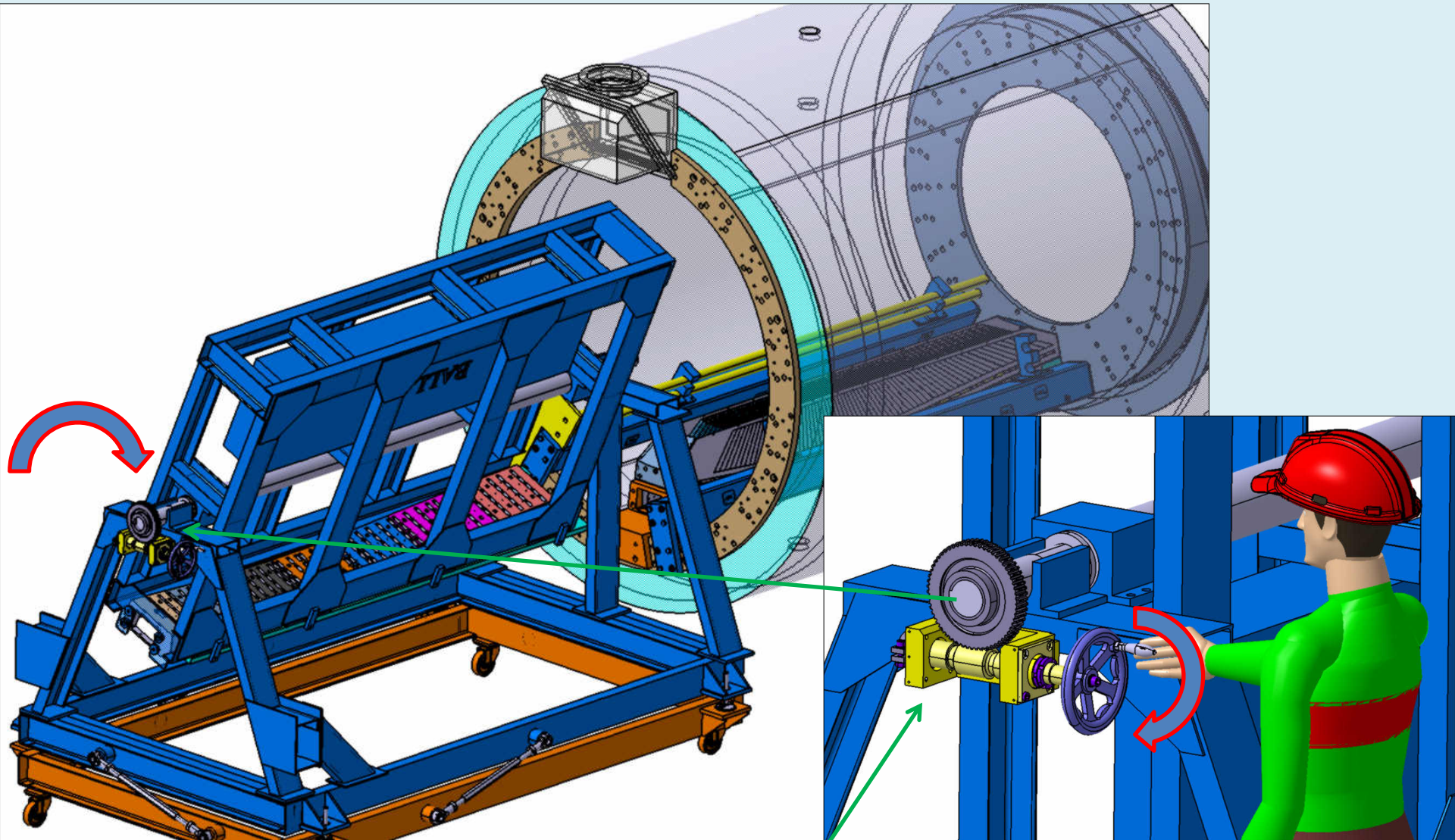
**STEP 11- Installation of the rotary device (cantilever) in the preliminary position.
Installation and attachment of the slice to the rotating platform .**



Procedures:

- The following slice to be install on the rotary platform of technological device;
- Adjusting of the slice and installation special guide rails to fix the slice on the platform.

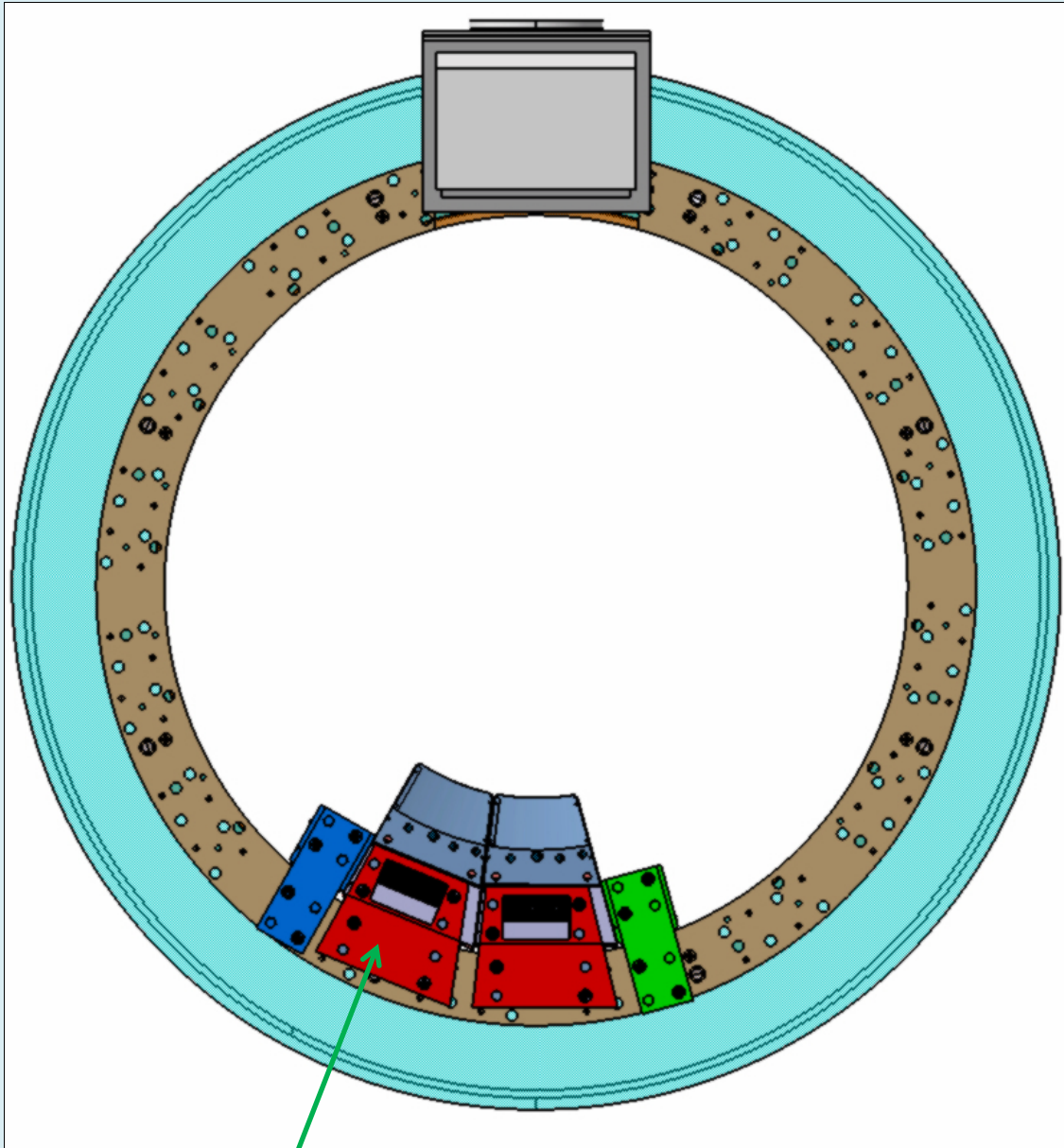
STEP 12 Rotating and adjusting of technological device according to the position of technological beam and previous slice



Procedures:

- Rotating technological device by means of transfer worm;
- Adjusting of the tilting according to position of technological beam and previous slice;
- Push the slice till contact with rear flange.

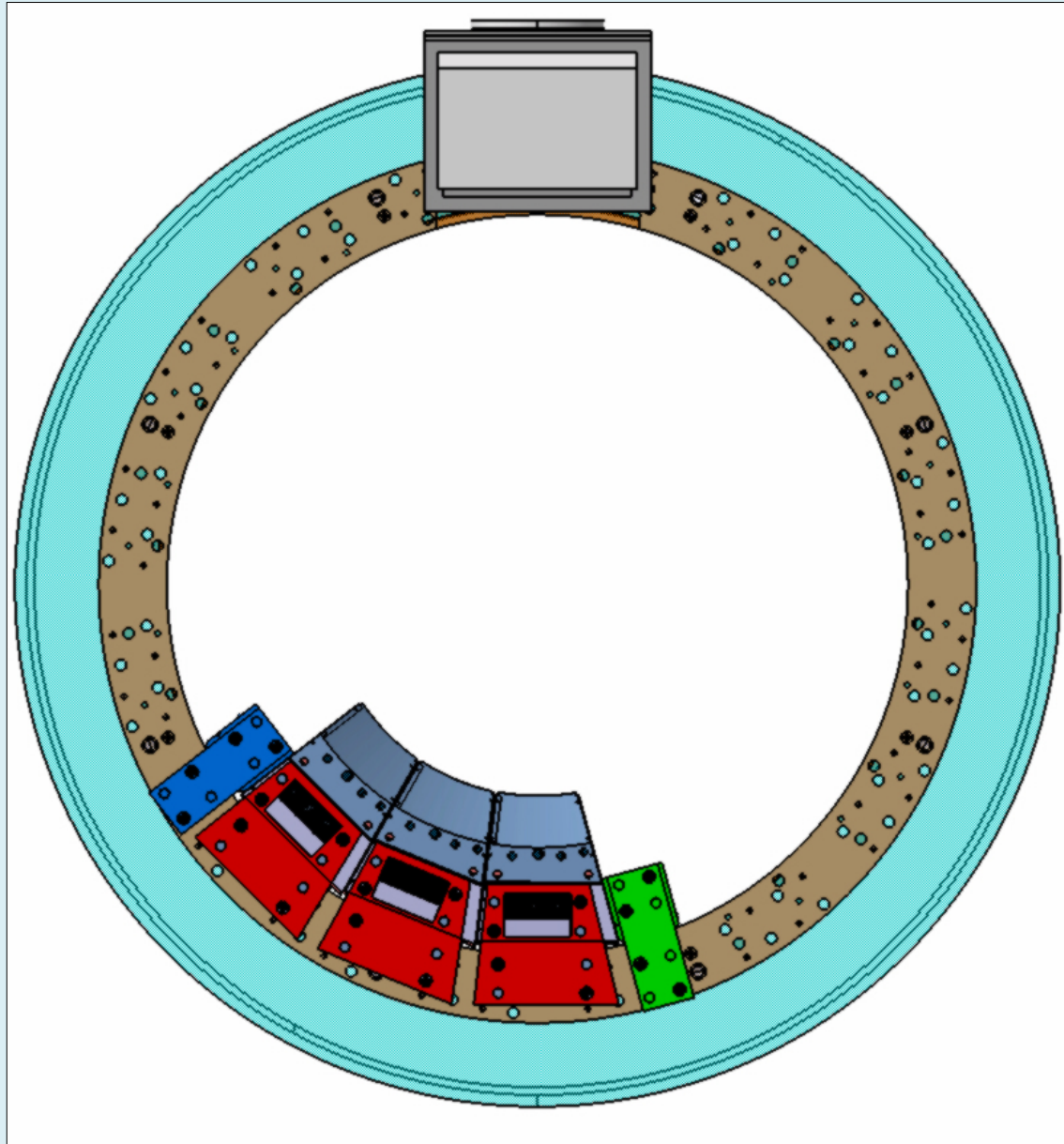
STEP 13- Slice mounting at the working position



Procedures:

- Slice to be fixed to the downstream ring with the use of 2 centering pins and 2 bolts M16 and by the bracket from upstream side.

STEP 14- Assembly continue

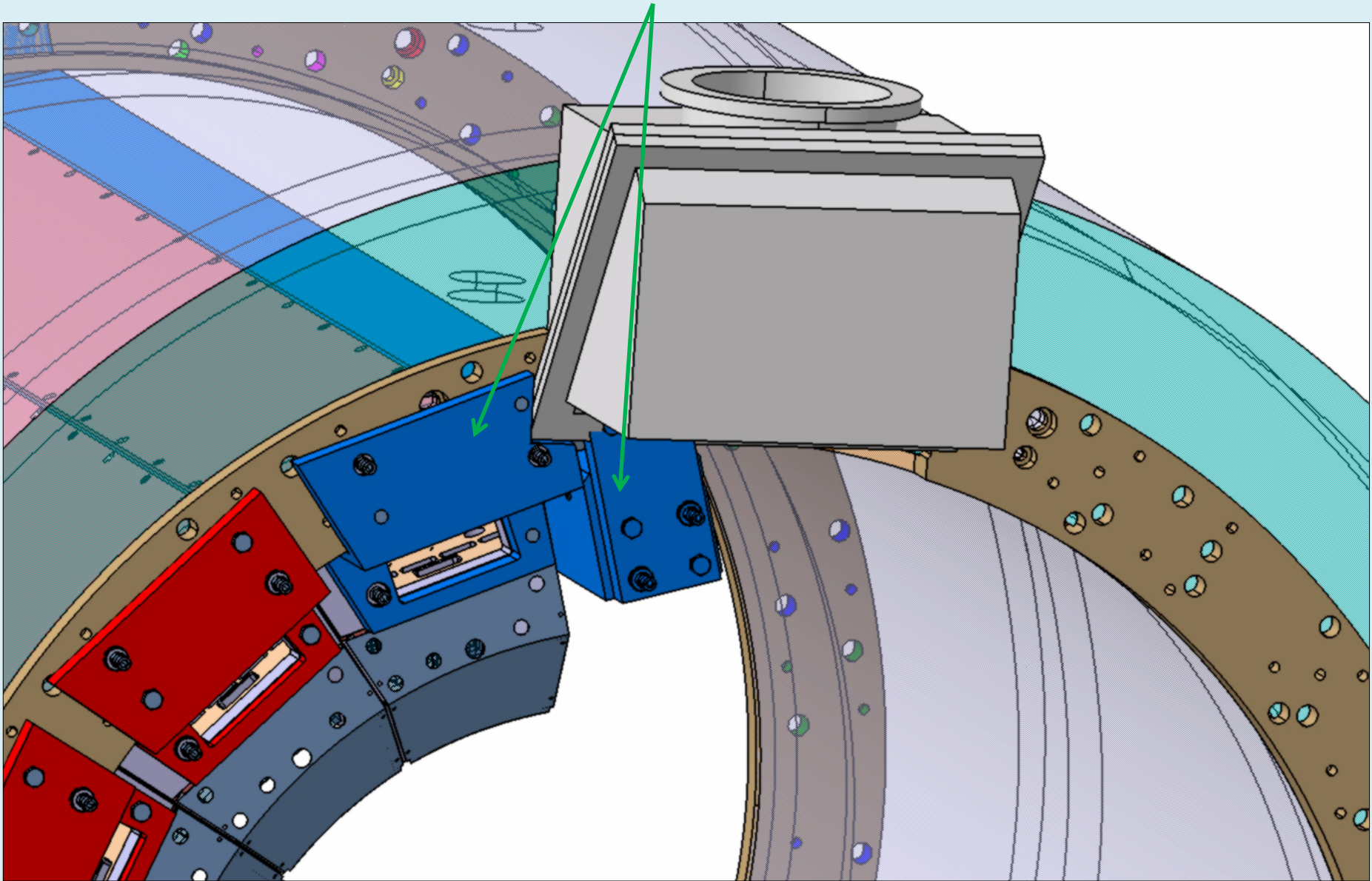


Procedures:

- The same procedures as with the following slice.

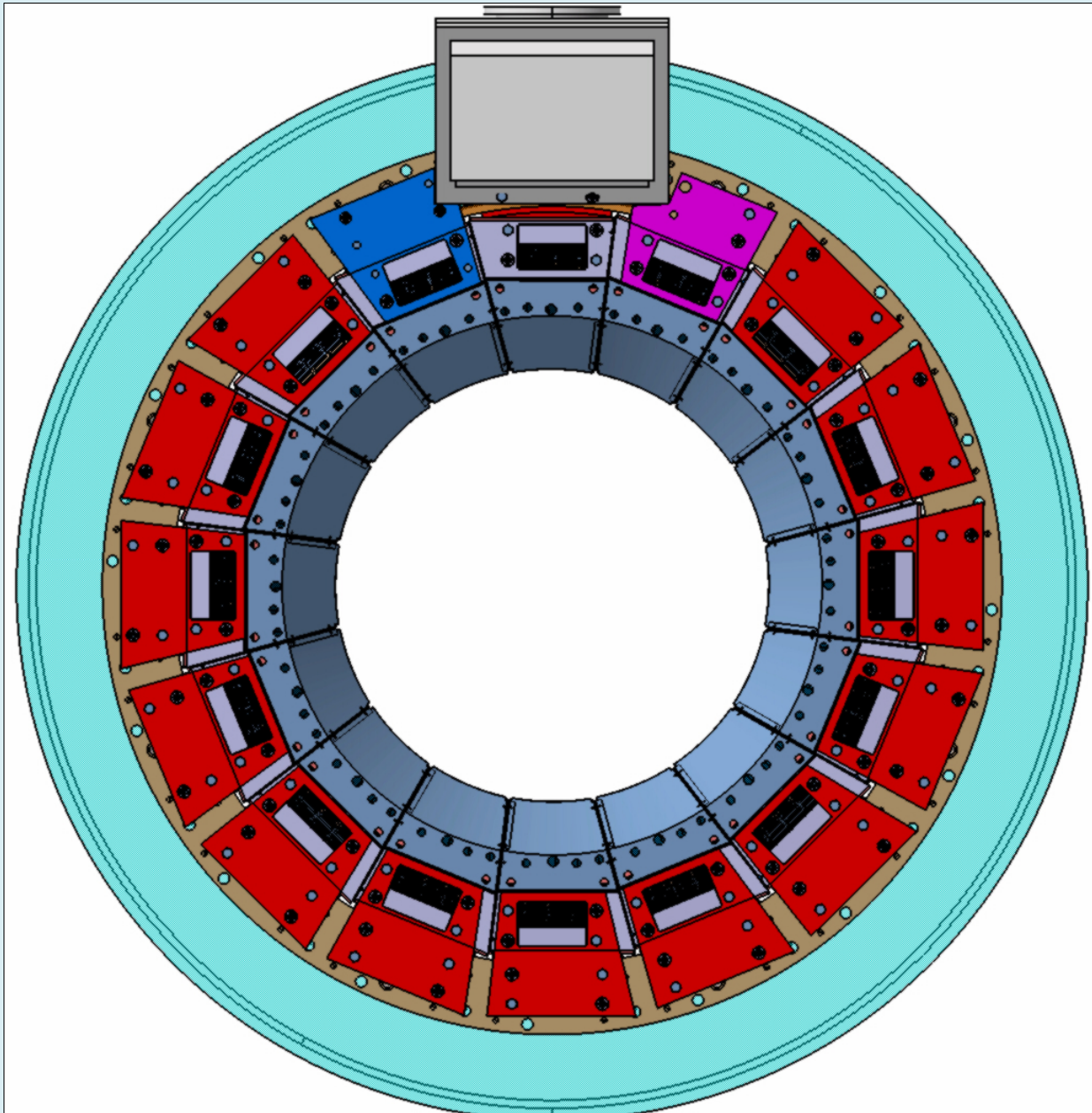
STEP 16- Assembly continue

PROBLEM- The installation of the slice is impeded by the current lead.
The technological beam and the bracket have to be original



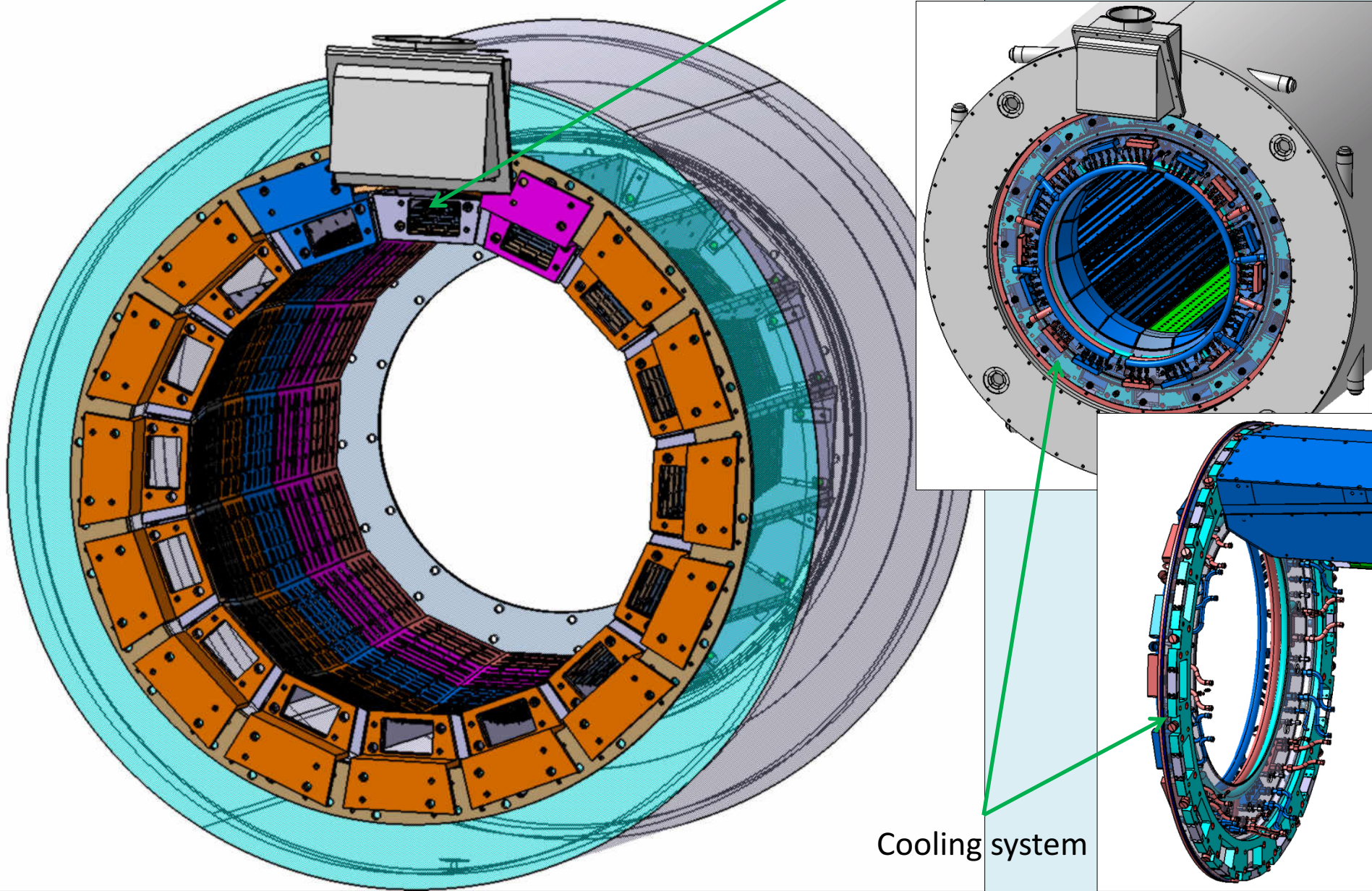
STEP 17- Assembly continue

The same procedures for right side slices as with the left side slices

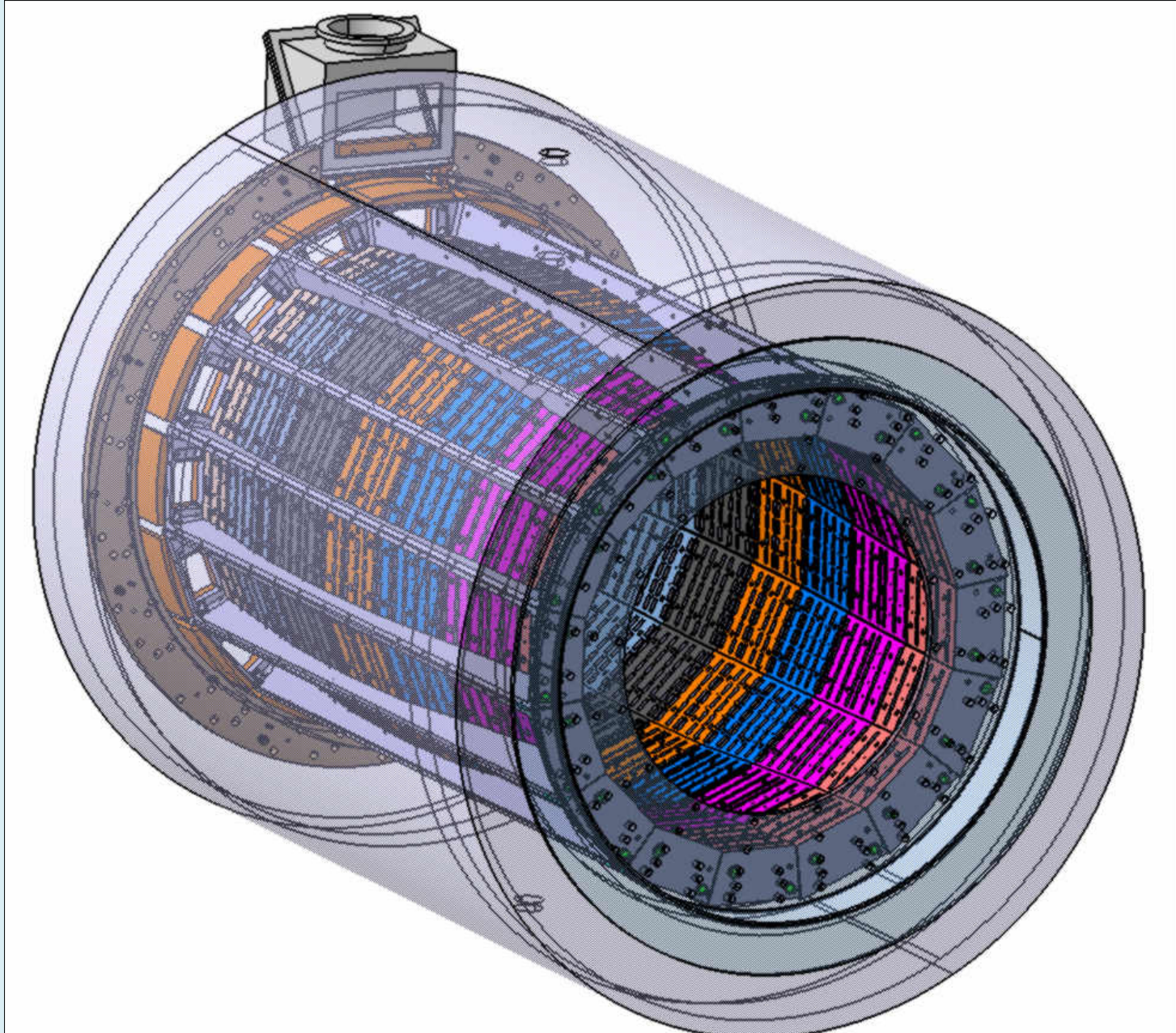


STEP 18- Assembly continue

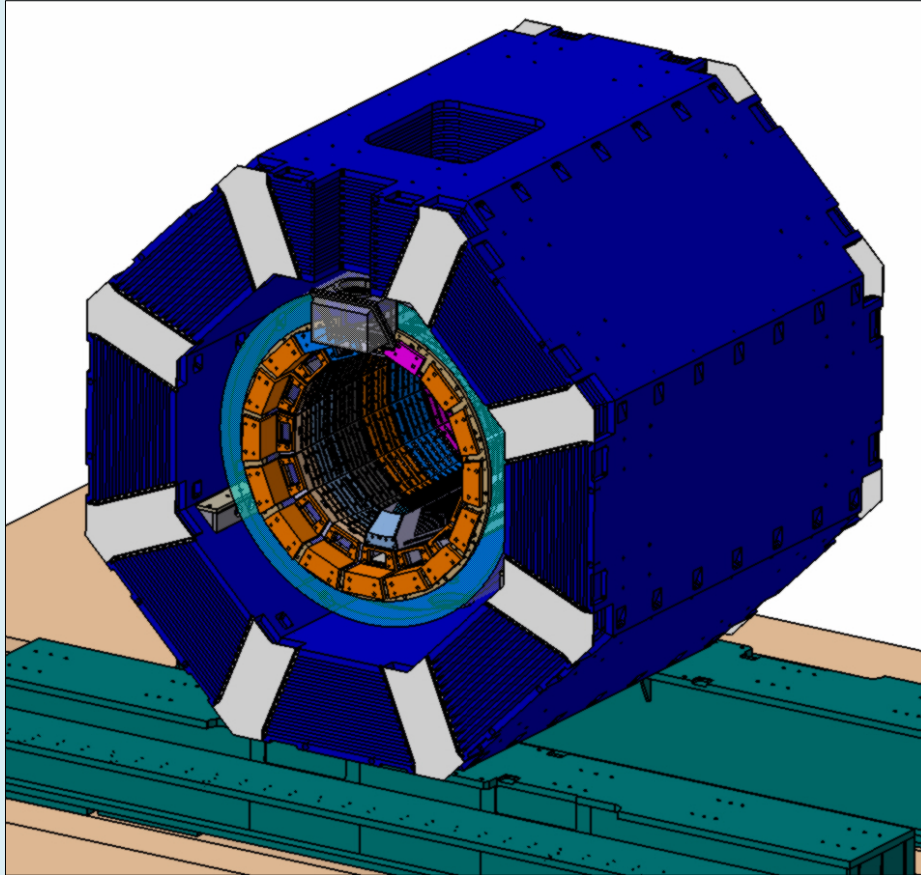
PROBLEMS- There is no place for fixing bracket,
problem with cooling system for the Barrel



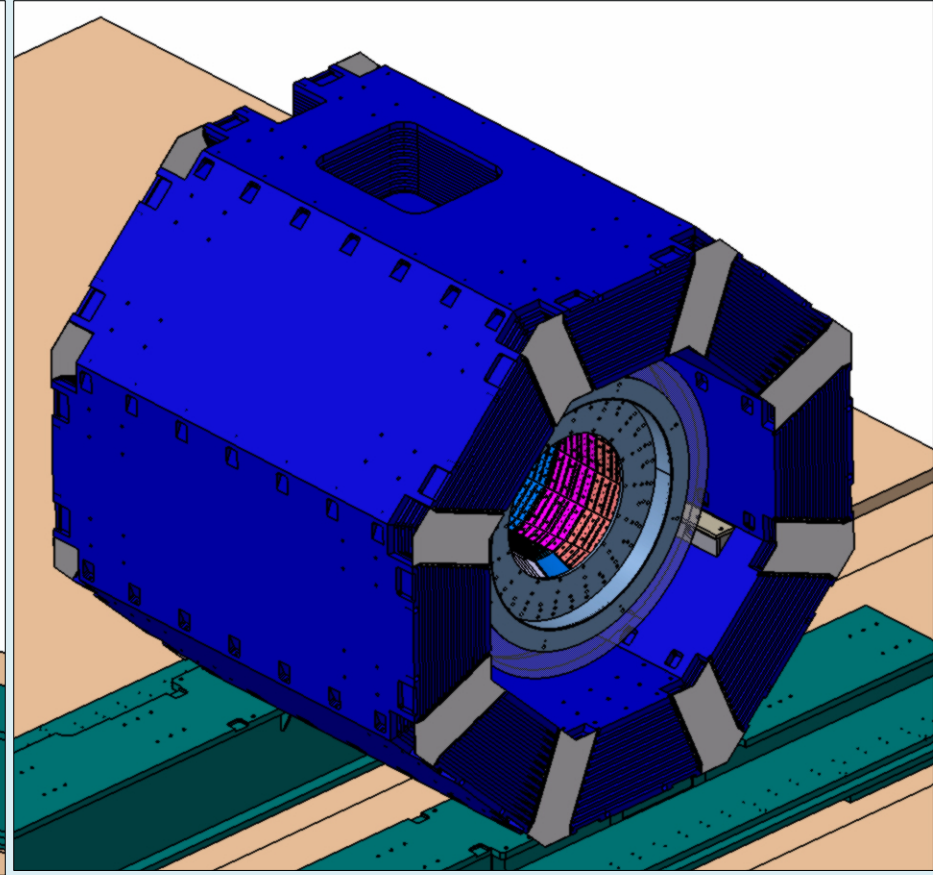
STEP 19- Assembly continue
View from downstream side



Completely simplified view of EMC



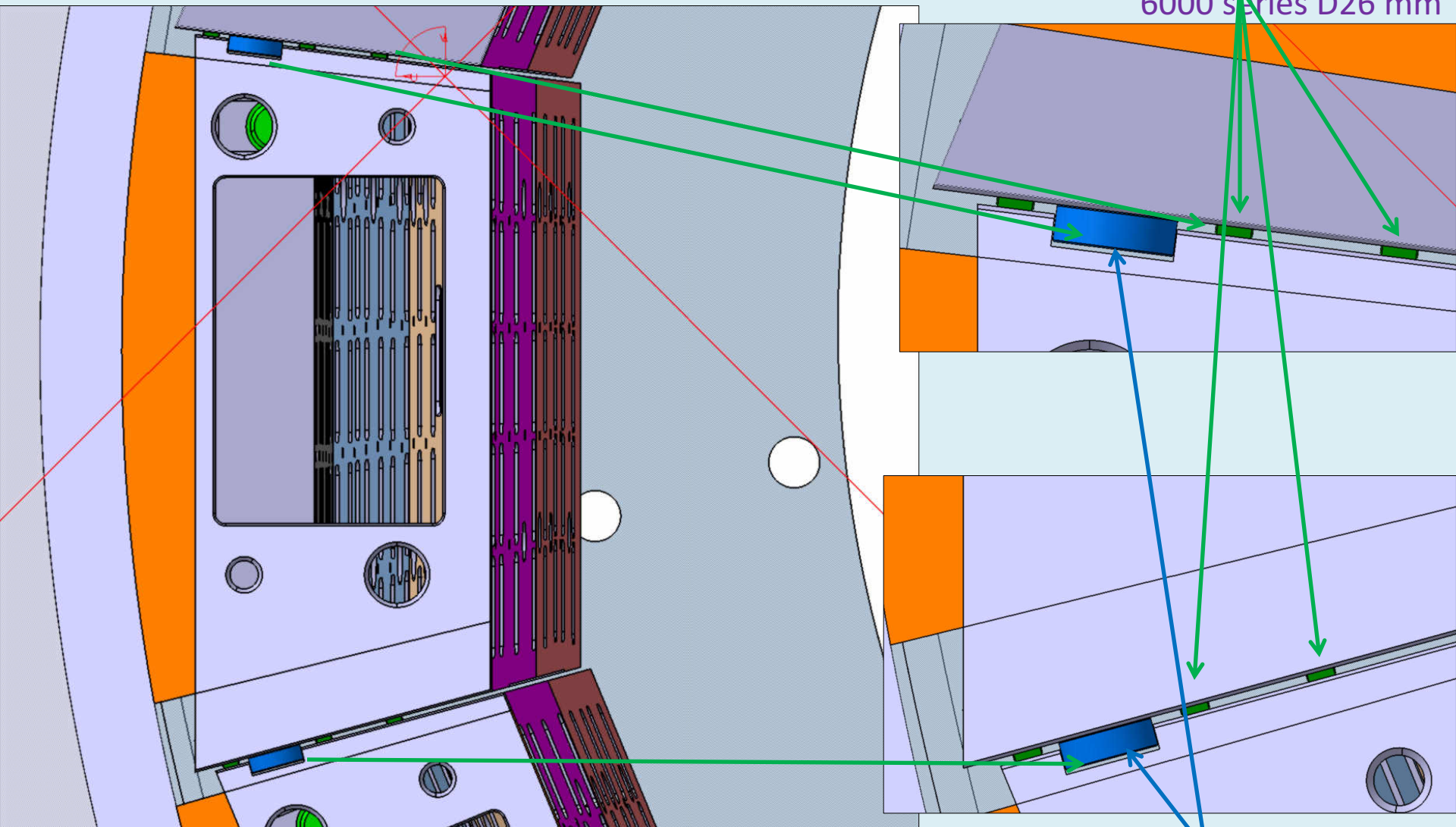
**Barrel + Cryostat + Magnet Assembly
(Upstream side view)**



**Barrel + Cryostat + Magnet Assembly
(Downstream side view)**

Transversal section of the barrel (simplified view)

Disposition of the bearings

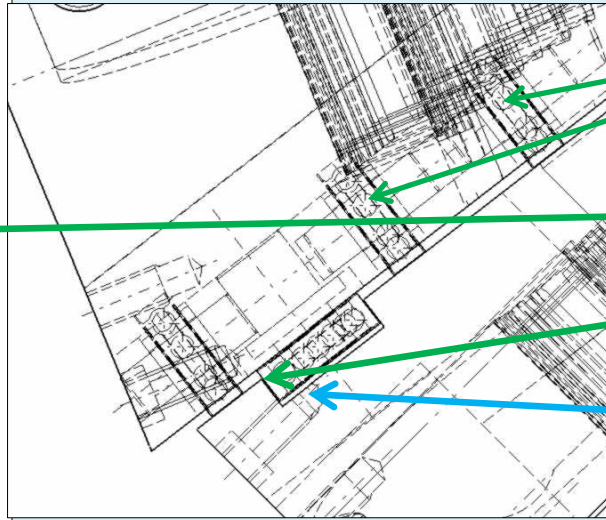
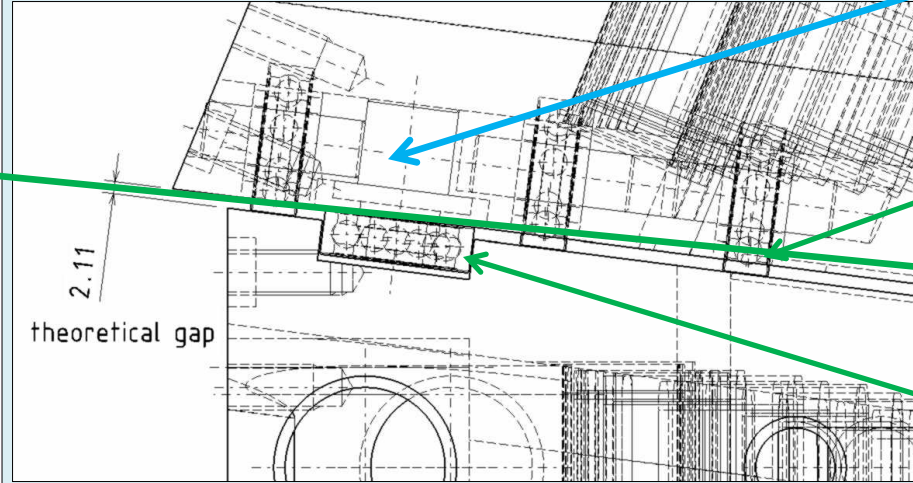
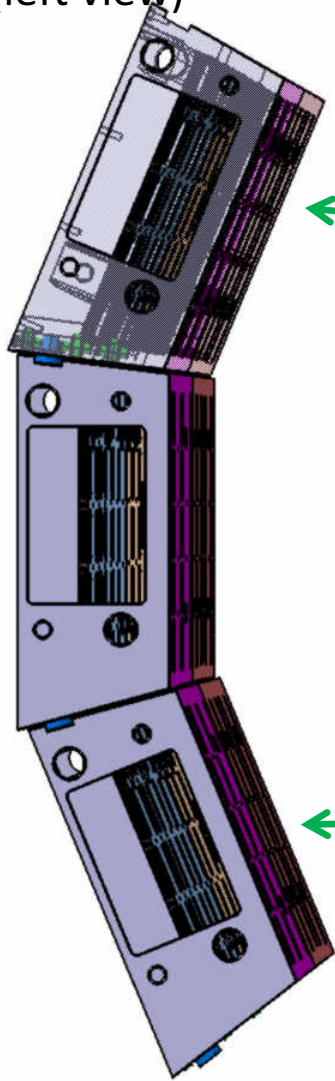


Positioning bearings
6000 series D26 mm

Rolling bearings
6000 series D26 mm

Partial view of Barrel
(left view)

Transversal section of the barrel (simplified view)
Disposition of the bearings



Rolling bearings
6000 series D26 mm

Positioning bearings
6000 series

Beginning from this slice
upper slice supports on
inner surface of the slot

Positioning bearings
6000 series

Beginning from this slice upper
slice supports on outer surface
of the slot

Rolling bearings
6000 series D26 mm

It means that transversal dimension of the slot must be max 27 mm if we have outer diam. of the bearing 26 mm. In this case we can adjust slice to the rings by means of centering pins.

5. CALCULATIONS

1

ELEMENTS

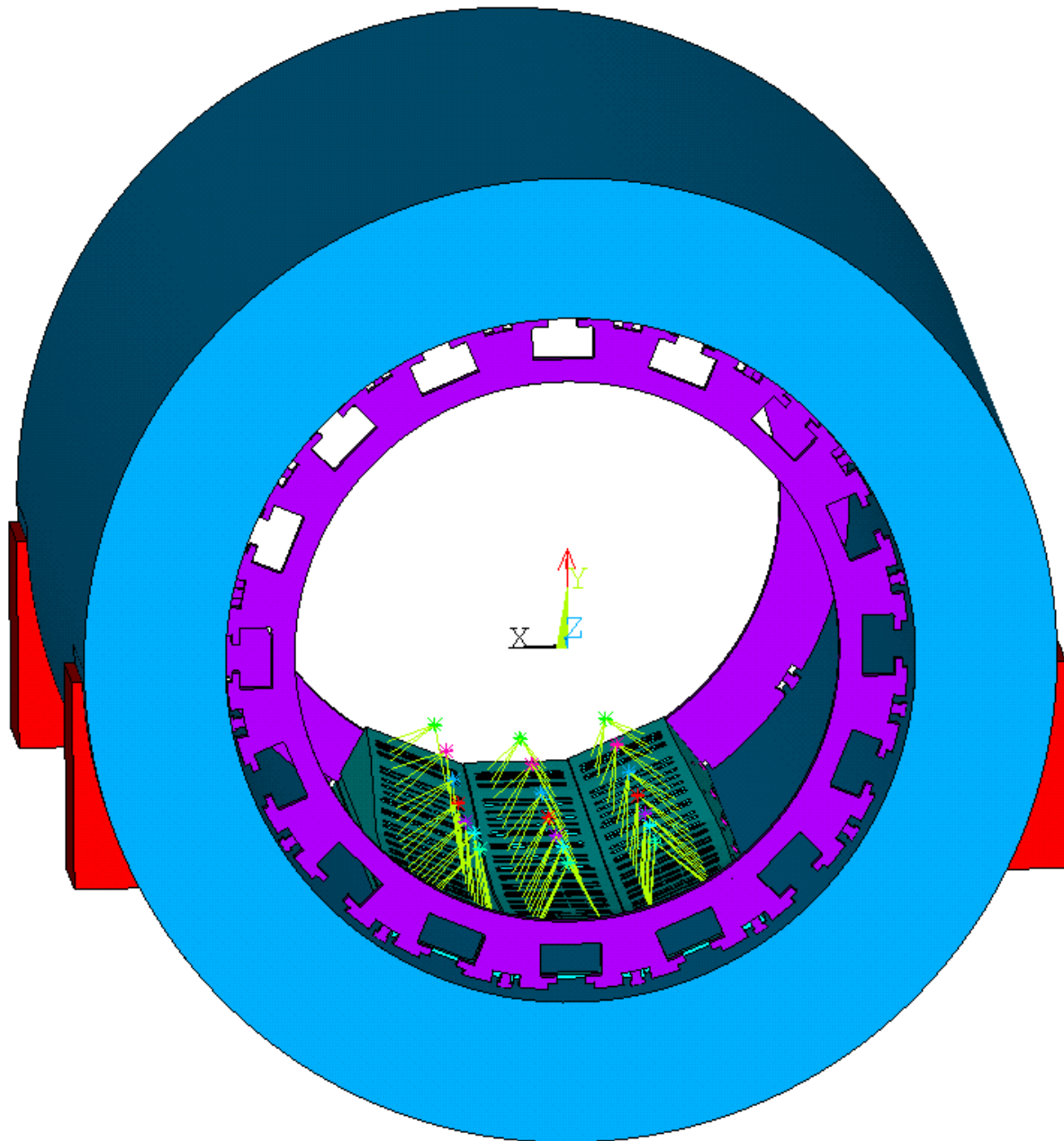
REAL NUM

ACEL

ANSYS
R14.5

Academic

FEB 21 2018
17:59:27
PLOT NO. 1



CALCULATIONS

ANSYS
R14.5

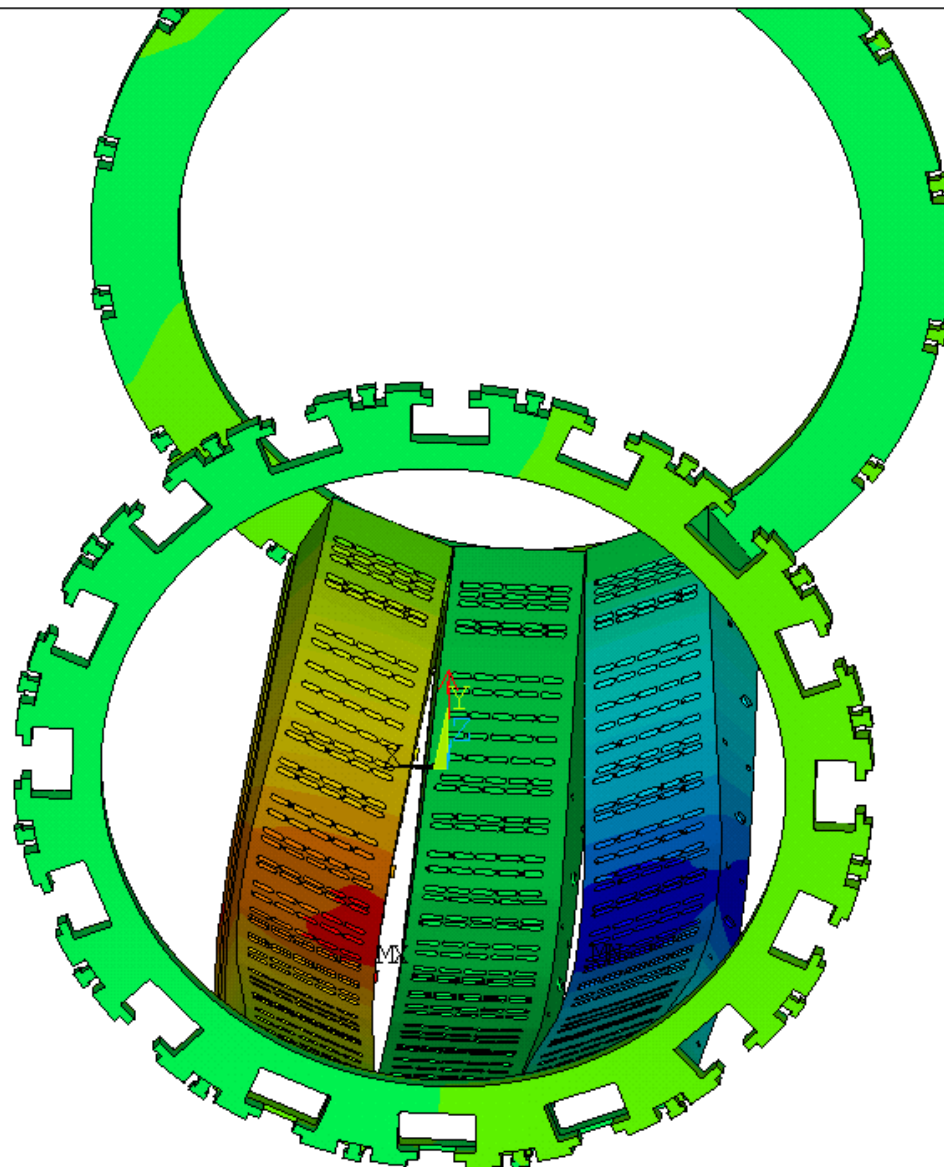
Academic

FEB 21 2018
17:56:51
PLOT NO. 1

1
NODAL SOLUTION

STEP=1
SUB =1
TIME=1
UX (AVG)
RSYS=0
DMX =2.89206
SMN =-1.06112
SMX =1.0582

ACEL



-1.1 -0.8 -0.5 -0.2 0.1 0.4 0.7 1 1.1

PM3:Displacement UX[mm]

CALCULATIONS

1

NODAL SOLUTION

STEP=1

SUB =1

TIME=1

UY (AVG)

RSYS=0

DMX =2.89206

SMN =-2.89173

SMX =.013758

ACEL

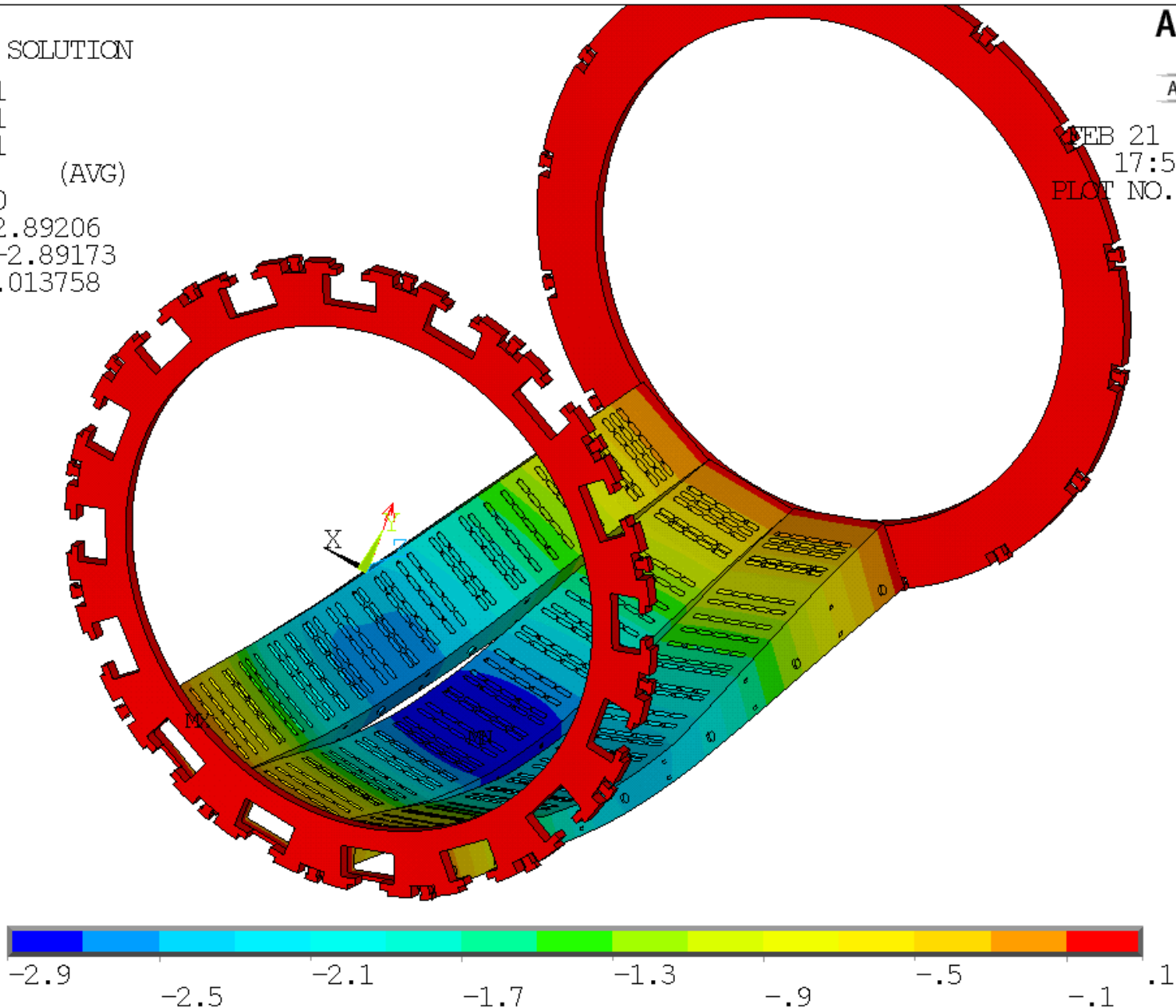
ANSYS
R14.5

Academic

FEB 21 2018

17:50:18

PLOT NO. 1



PM3:Displacement UY [mm]

CALCULATIONS

1

NODAL SOLUTION

STEP=1

SUB =1

TIME=1

UZ (AVG)

RSYS=0

DMX =2.89206

SMN =-.300275

SMX =.32392

ACEL

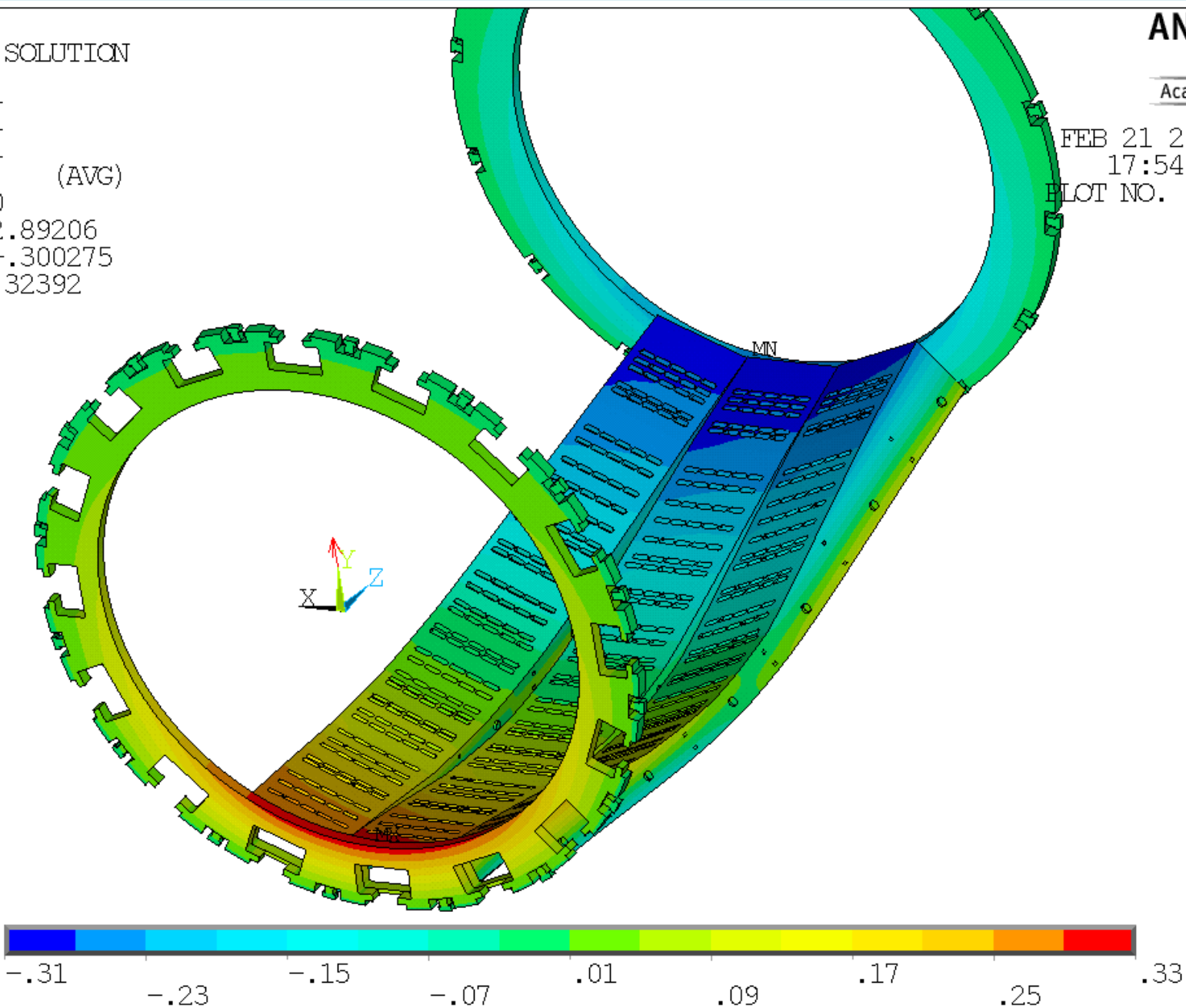
ANSYS
R14.5

Academic

FEB 21 2018

17:54:02

PLOT NO. 1

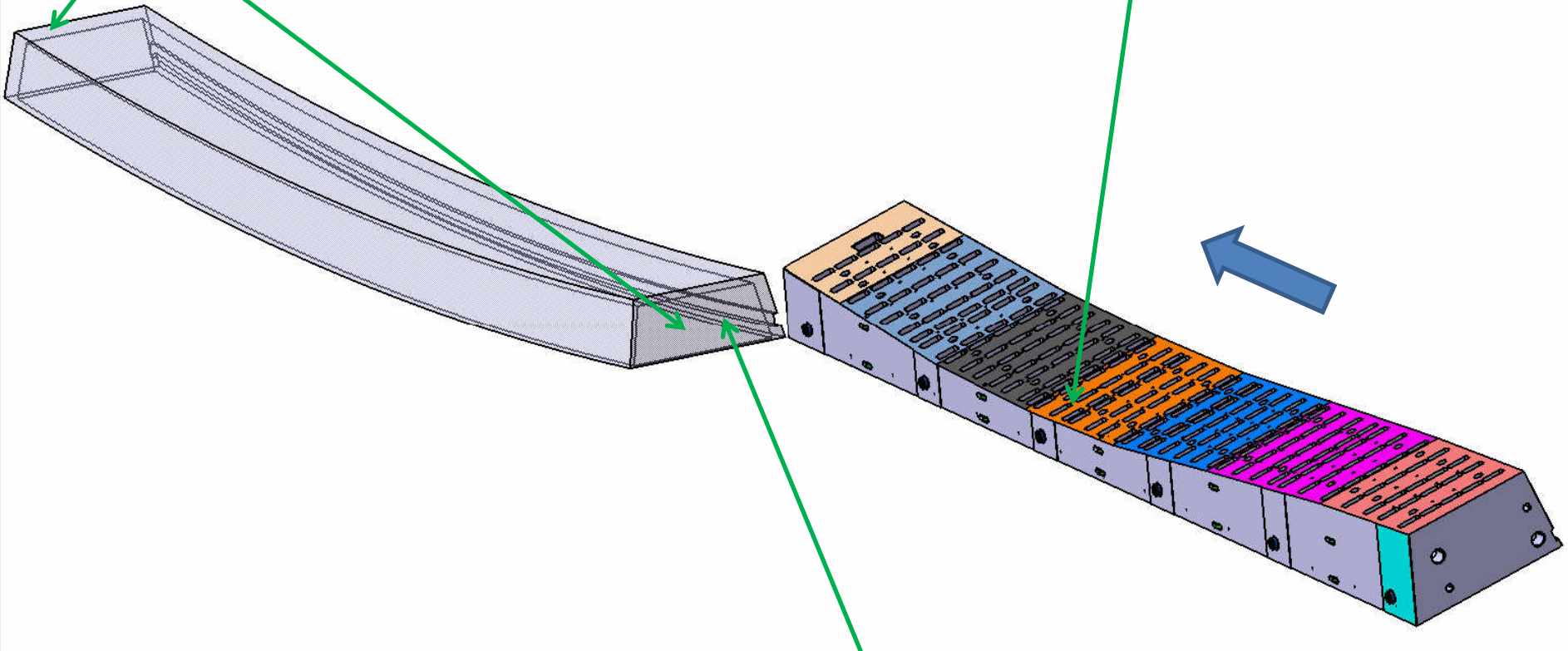


PM3:Displacement UZ [mm]

Situation during installation of the next slice (very simplified view)

Slice inside of the cryostat
has fixed from both sides
(Simplified 3d model)

Slice outside of the cryostat
during of rolling in to Cryostat
(Simplified 3d model)



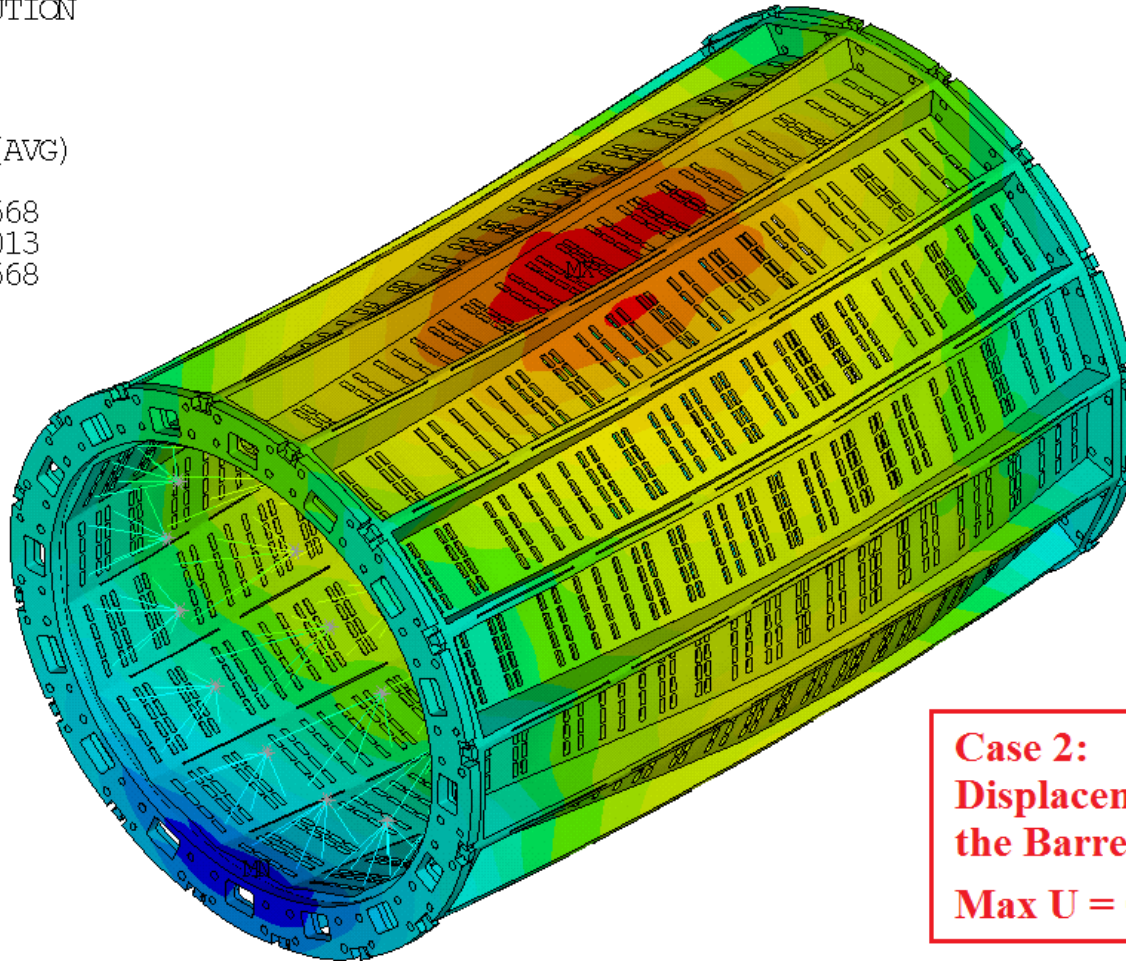
According to the calculation the slice inside of the cryostat has deformation 2,89 mm in the middle part of the beam, it's slot also has the deformation.
During the rolling in **the jamming may occurs** because the diameter of the bearing is 26 mm and the dimension of the slot is 27 mm.

FOR COMPARISON

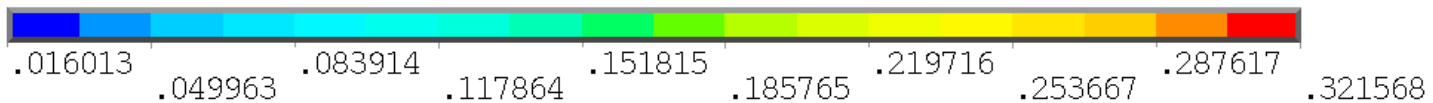
OVERALL DISPLACEMENT IN MAIN VERSION OF BARREL STRUCTURE

ANSYS
R14.5
Academic

1
NODAL SOLUTION
STEP=1
SUB =1
TIME=1
USUM (AVG)
RSYS=1
DMX =.321568
SMN =.016013
SMX =.321568

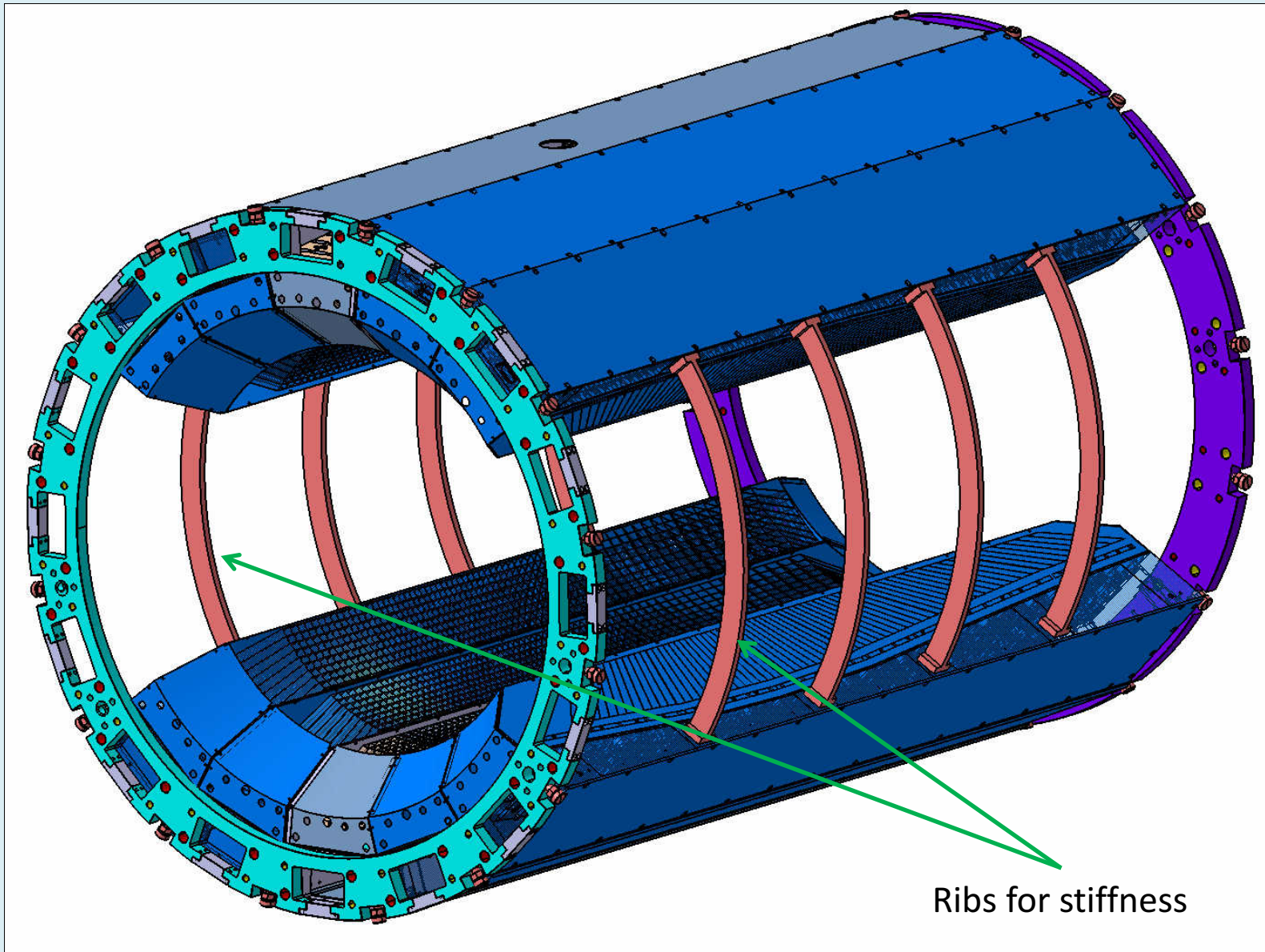


**Case 2:
Displacements in
the Barrel.
Max U = 0.32 mm**



Case 2: Overall Displacements USUM [mm].

6. STAGED APPROACH FOR THE MAIN VERSION OF BARREL STRUCTURE



7. ADVANTAGES AND DISADVANTAGES OF MODULAR VERSION, CONCLUSIONS

1. Modular approach would allow one to assemble Barrel EMC in few stages with minimum disassembling of PANDA setup between experimental runs.
2. Procedures of additional assembly are easier because it is not needed to install support frames and central technological beam but only rotary device (cantilever) .

1. In comparison with Main Version the Modular version is more complicated.
2. Manufacturing of support beam must be done more precisely because in case of the Main version we can install spacers between slices to adjust gaps.

In the Modular version there is NO possibility of gap adjustment between neighboring slices at all. Problem with insertion of slice may occurs (jamming) due to deformations.

3. The stiffness of Modular Assembly much less then in case of Main Version because in Main Version all Slices are joint together by means of spacers and fixing bolts.
4. Thermal insulation of Modular Version will be more complicated.
5. We will have some problem with installation of the upper slice because of current lead.
6. Removal of any slice from EMC and returning it back may be problematic because of deformation of upper slice (it loses its support).

That's why we must make assembly procedure beginning from the lower slice.

According to design analysis and calculations of Main Version and alternative Modular Version N5 we can make a conclusions:

1. With the use of Modular Version we can NOT guaranty practical possibility and reliability of assembly.
2. The Main Version of Barrel EMC assembly is more realistic and reliable.

THANK YOU FOR ATTENTION !!!

