Project N5 - Investigation of Anticorodal Aluminum Structure of ITk Pixel PP1

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Project life cycle

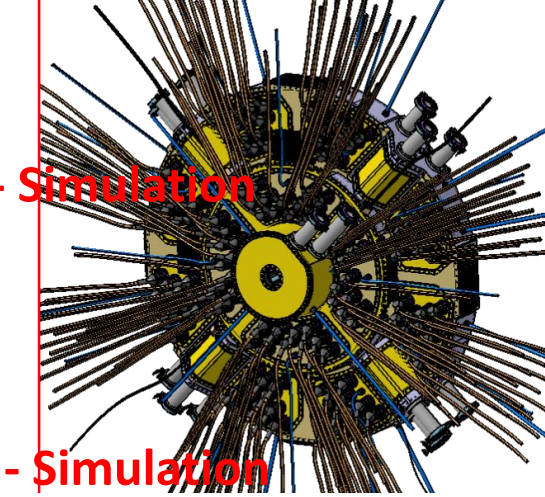
1. Compare Analyses (Volume, Weight, Dimensions, Positioning) – Detailed CAD Model vs. gmx – Simulation
2. Calculation of the Radiation Length (Xo) – Detailed CAD Model vs. gmx – Simulation
3. Simplification of the Detailed CAD Model
4. Calculation of the Radiation Length (Xo) – Detailed CAD Model vs. Simplified CAD Model
5. Integration Conflicts Checking
6. Codding, Check for similarity and internal conflicts checking

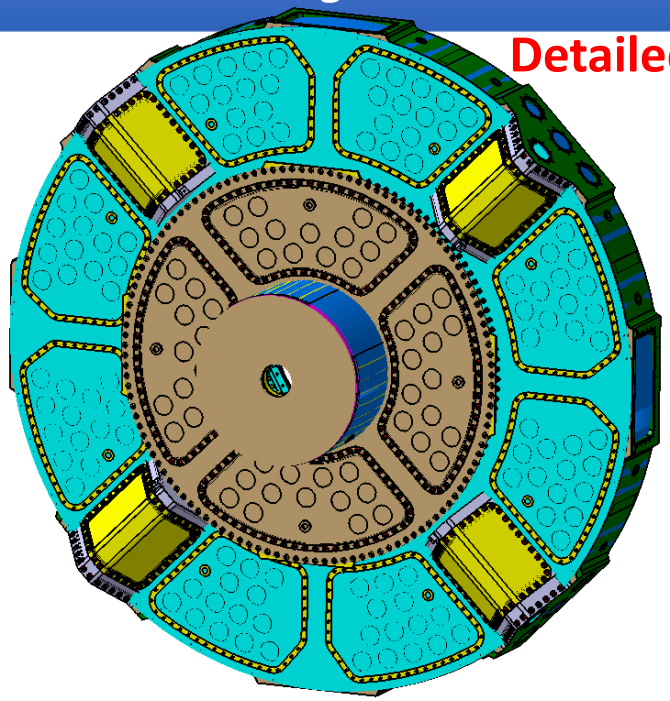
1. Compare Analyses - Volume, Weight, Dimensions, Positioning

Detailed CAD Model vs. gmx – Simulation

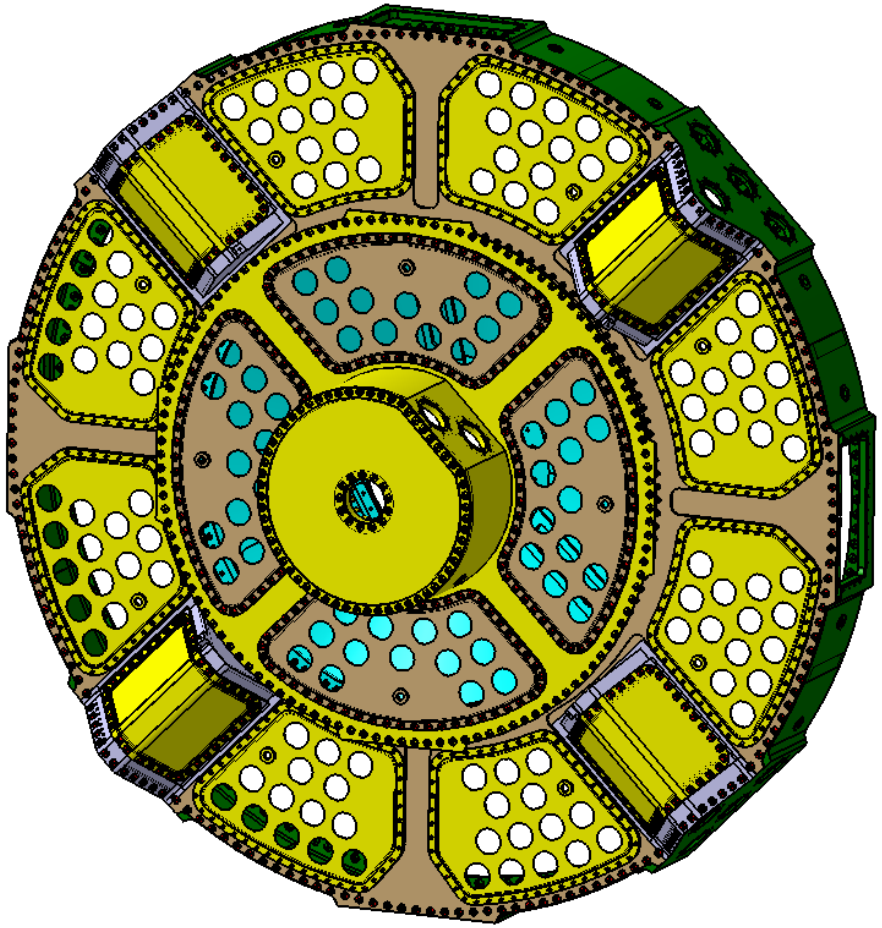
1. Compare Analyses - Detailed CAD model vs. gmx - Simulation

Detailed CAD Model + gmx - Simulation

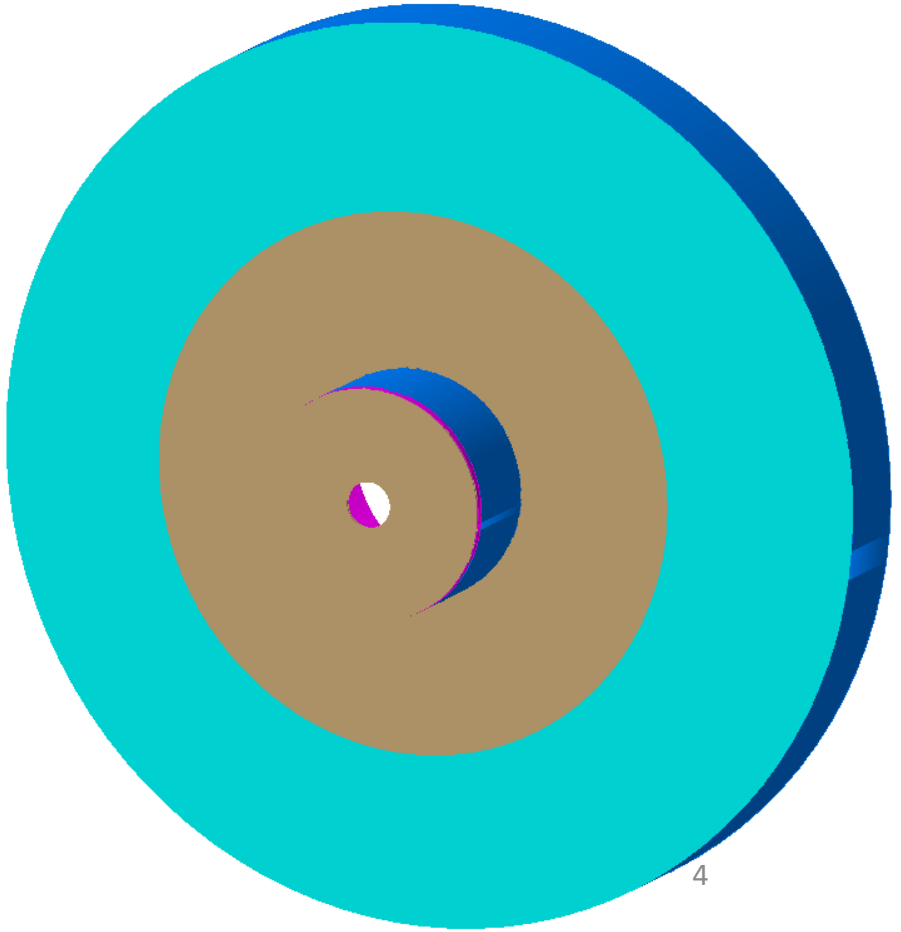




Detailed CAD Model

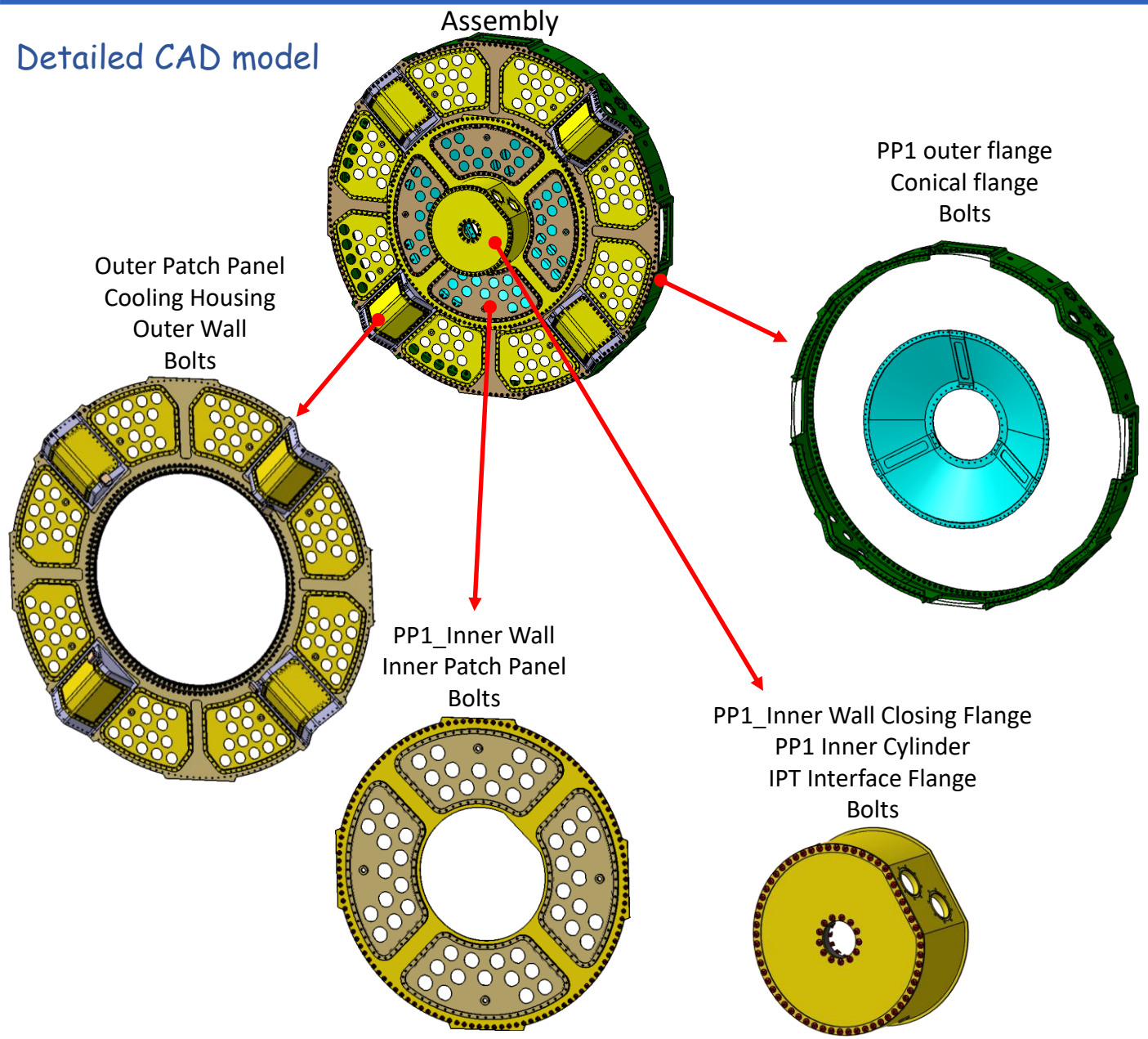


gmx - Simulation

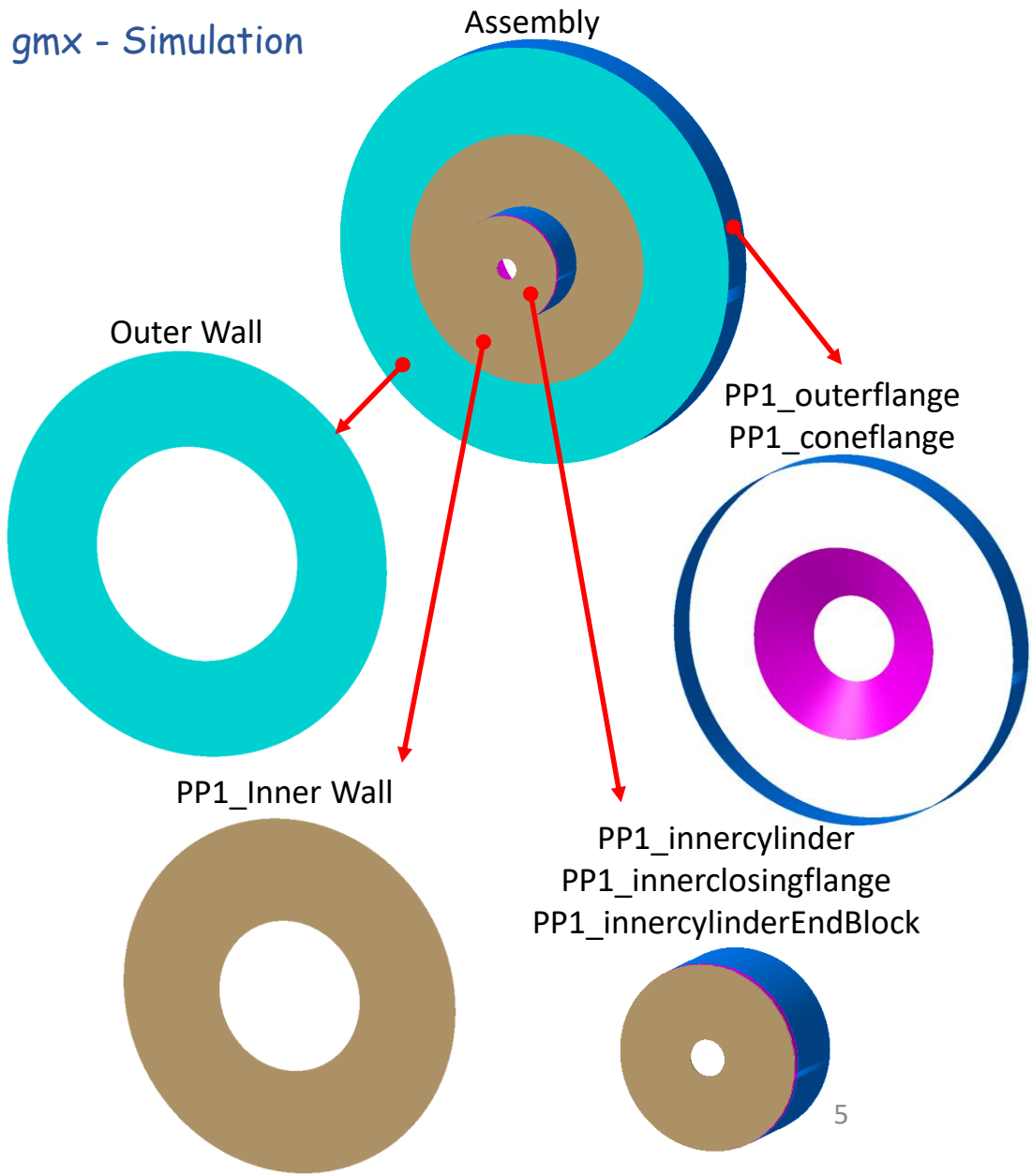


1. Compare Analyses - Detailed CAD model vs. gmx - Simulation

Detailed CAD model



gmx - Simulation



1. Compare Analyses - Detailed CAD model vs. gmx - Simulation

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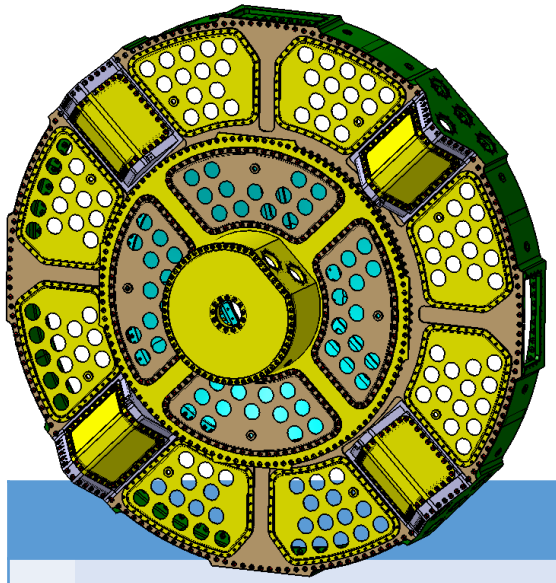

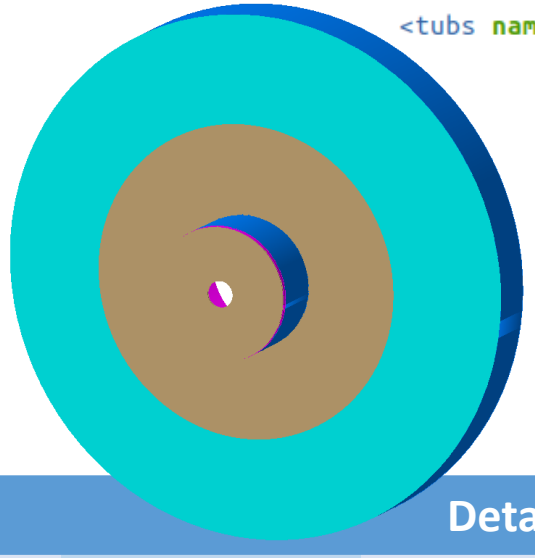

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<logvol name="PP1_outerwall" shape="PP1_outerwall_tubs" material="AlAnticorodal" />
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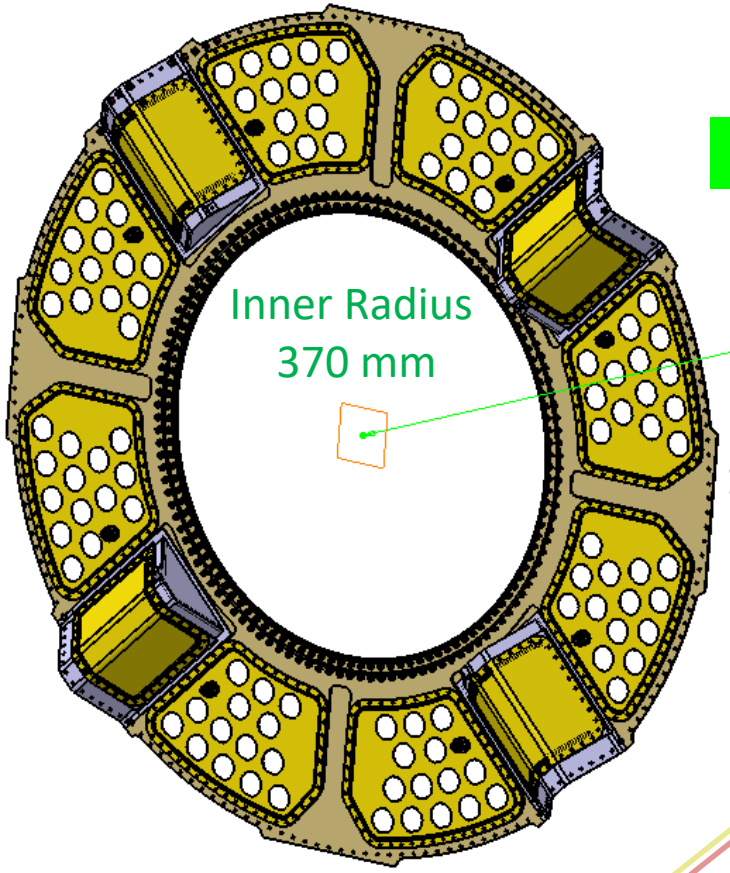
</material>
```

			Detailed CAD Model		gmx-Simulation	
#	Name	material	Volume (m^3)	Weight (kg)	Volume (m^3)	Weight (kg)
1	Outer Patch Panel, Cooling Housing, Outer Wall, Bolts	Antic. Aluminum	0.00383	10.3	0.00222	6
2	PP1_Inner Wall, Inner Patch Panel, Bolts	Antic. Aluminum	0.001075	2.9	0.000909	2.44
3	PP1_Inner Wall Closing Flange, PP1 Inner Cylinder, IPT Interface Flange, Bolts	Antic. Aluminum	0.00084	2.26	0.00105	2.82
4	PP1 outer flange, Conical flange, PP1 outer flange, Bolts	Antic. Aluminum	0.006004	16.16	0.00141	3.79
		Total:	**0.011749**	**31.62**	**0.005589**	**15.05**

Diff: -16.6 kg (52.5%)

1. Compare Analyses – Dimensions and Positions (Outer Patch Panel, Cooling Housing, Outer Wall, Bolts)

CAD model



Inner Radius
370 mm

Outermost Radius
712.5 mm

3160.5 mm

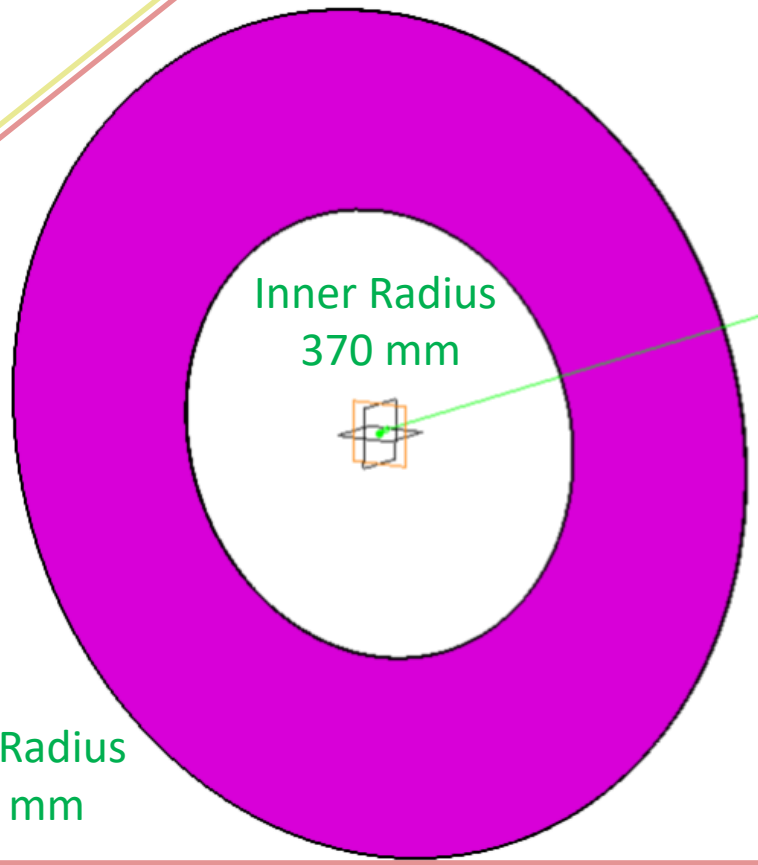
Z

Thickness
1 mm – 12 mm

gmx - Simulation

3164 mm

Z



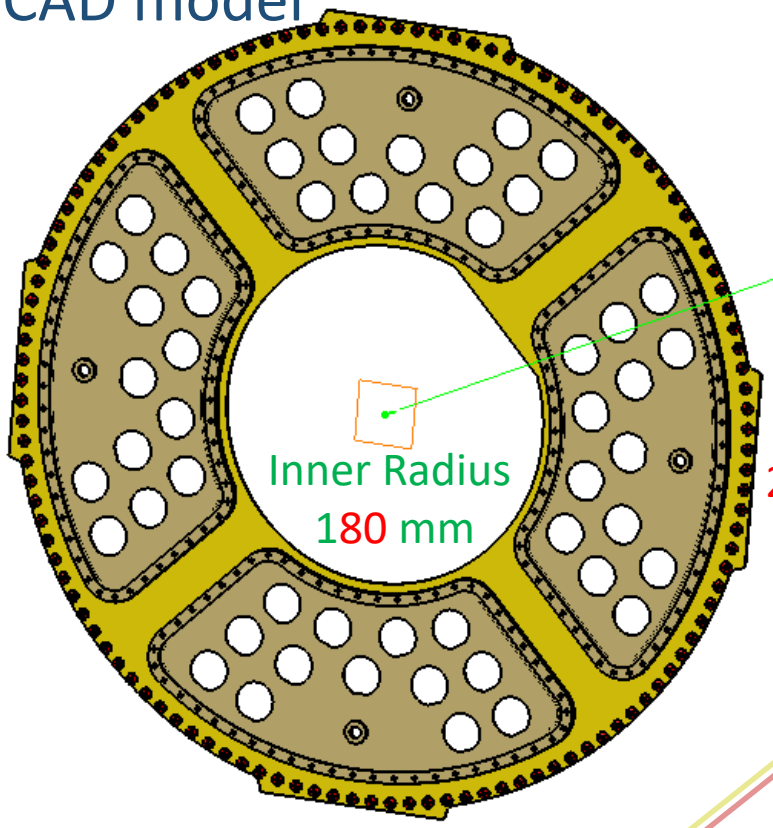
Inner Radius
370 mm

Outer Radius
700 mm

Thickness
2mm

1. Compare Analyses – Dimensions and Positions (PP1_Inner Wall, Inner Patch Panel, Bolts)

CAD model



Inner Radius
180 mm

Outer Radius
419 mm

gmx - Simulation

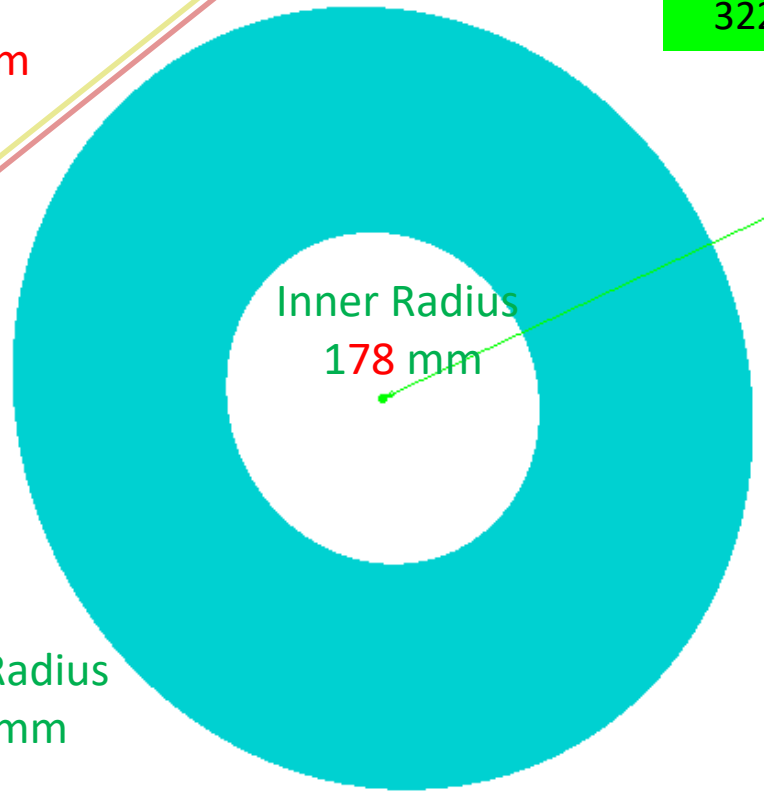
3223 mm

Z

Thickness
2 mm – 8 mm

3225 mm

Z



Inner Radius
178 mm

Outer Radius
420 mm

Thickness
2mm

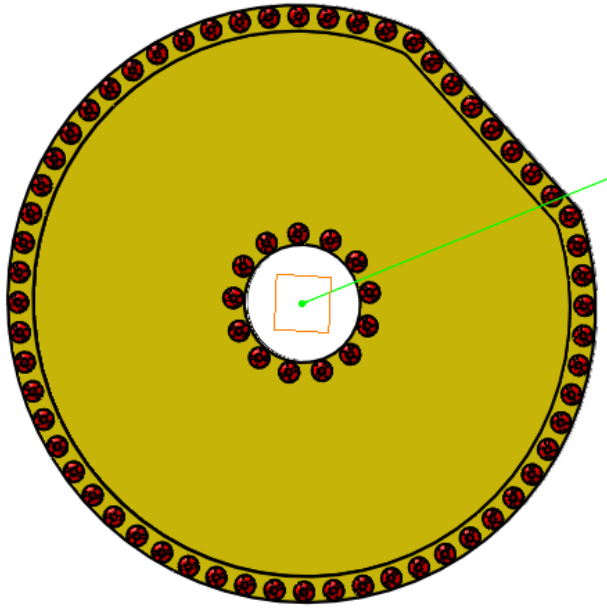
1. Compare Analyses – Dimensions and Positions (PP1_Inner Wall Closing Flange, PP1 Inner Cylinder, IPT Interface Flange, Bolts)

CAD model

gmx - Simulation

3384.5 mm

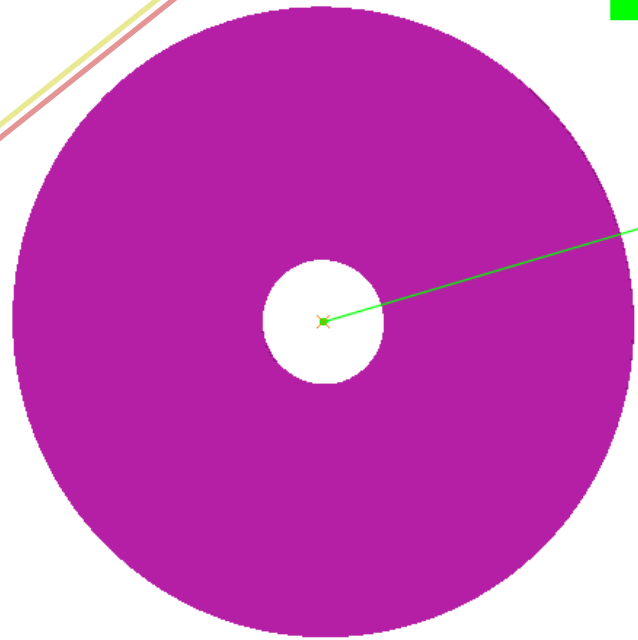
Z



Thickness
1 mm – 5 mm

Inner Radius
35.5 mm

3391.5 mm



Thickness
5 mm

Outer Radius
179.5 mm

1. Compare Analyses – Dimensions and Positions (PP1_Inner Wall Closing Flange, PP1 Inner Cylinder, IPT Interface Flange, Bolts)

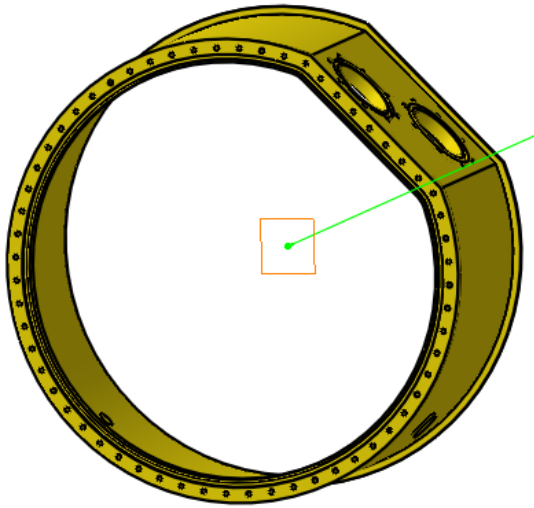
CAD model

gmx - Simulation

3302 mm

z

Thickness
162mm



Inner Radius
165

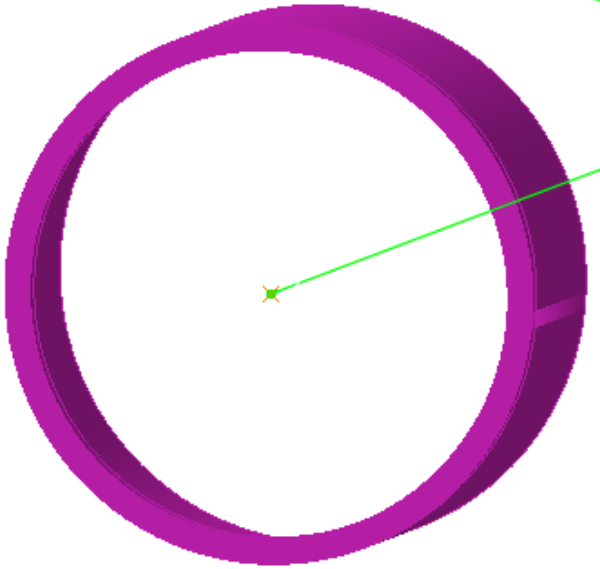
Outermost Radius
186 mm

3308 mm

Thickness
162 mm

Innermost Radius
178 mm

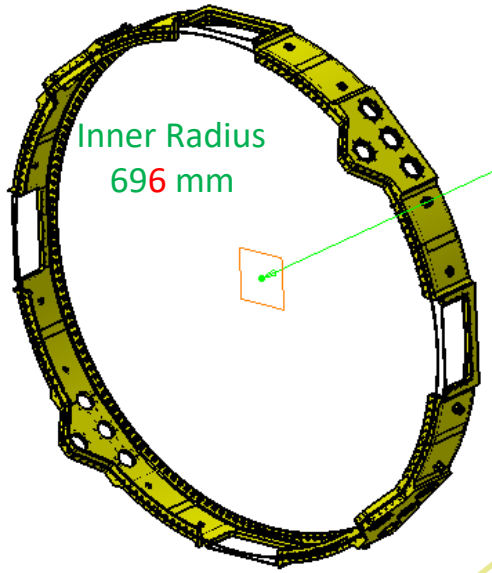
Outer Radius
180 mm



1. Compare Analyses – Dimensions and Positions (PP1 outer flange, Conical flange, Bolts)

CAD model

Thickness
4mm – 12 mm



3089 mm

Z

Inner Radius
696 mm

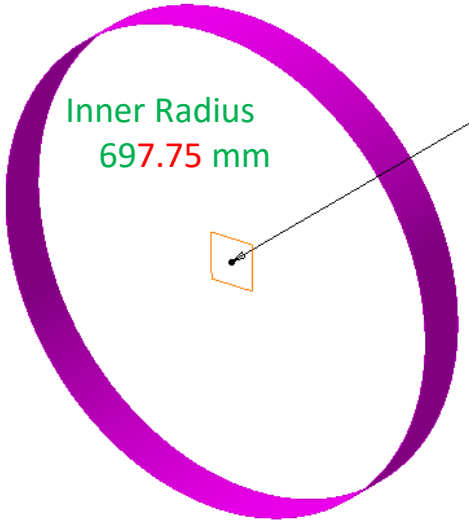
maxLength 221 mm

Outer Radius
700 mm

gmx - Simulation

3091.50 mm

Z



Inner Radius
697.75 mm

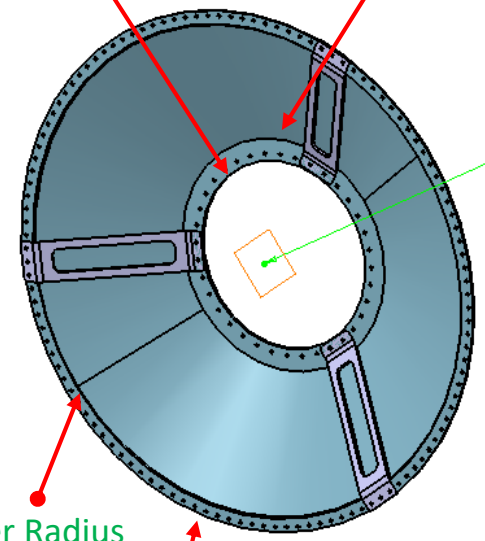
Length 143 mm

Thickness
1.95mm

Outer Radius
699 mm

1. Compare Analyses – Dimensions and Positions (PP1 outer flange, Conical flange, Bolts)

CAD model



Inner Radius
141 mm

Outer Radius
165 mm

Length 101.5 mm

3115.24mm

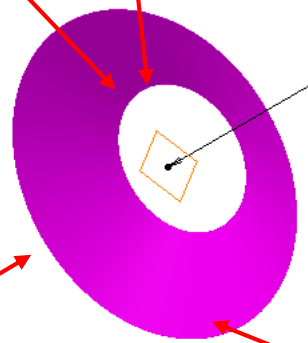
Z

Thickness
3mm – 6.46 mm

Inner Radius
367 mm

Outer Radius
389 mm

gmx - Simulation



Inner Radius
166.5mm

Outer Radius
165 mm

3113.48mm

Length 99.16 mm

Thickness
3mm

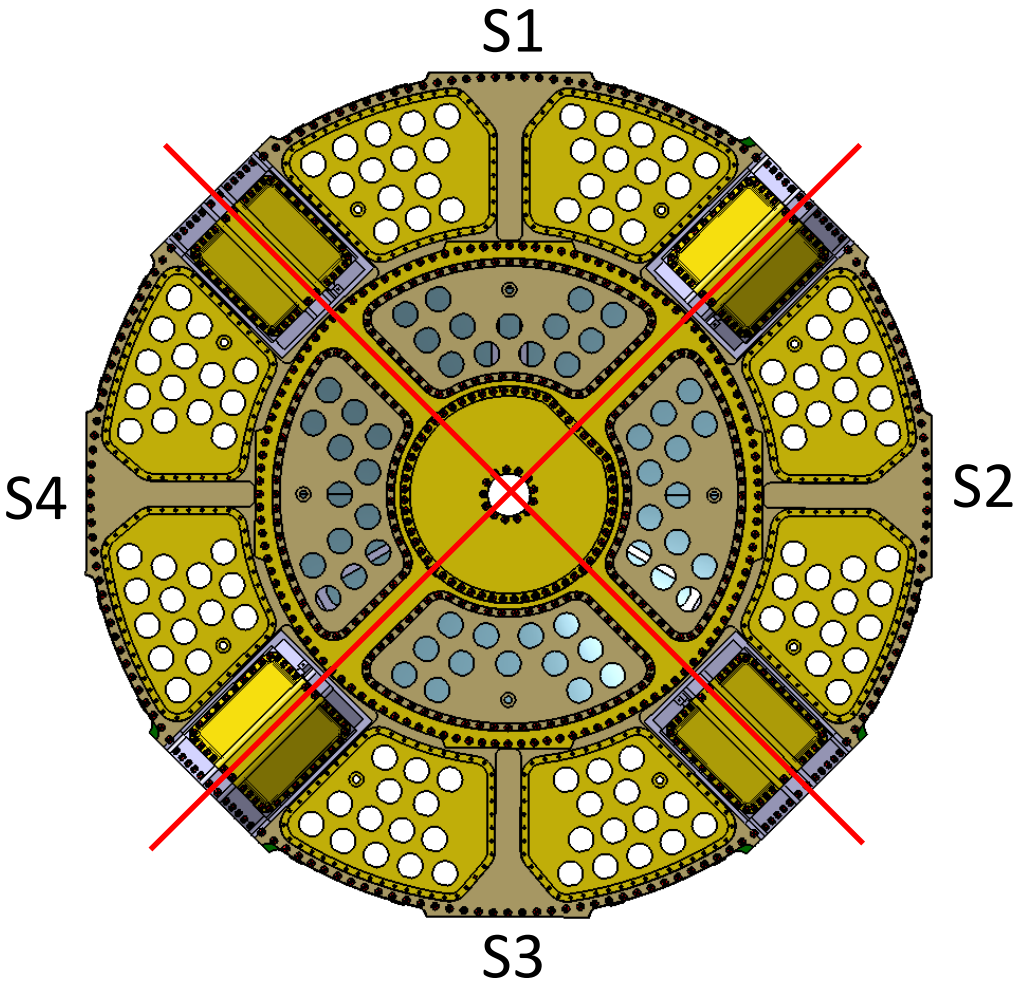
Outer Radius
369.43 mm

Inner Radius
368.41mm

2. Calculation of the Radiation Length (Xo)

Detailed CAD Model vs. gmx – Simulation

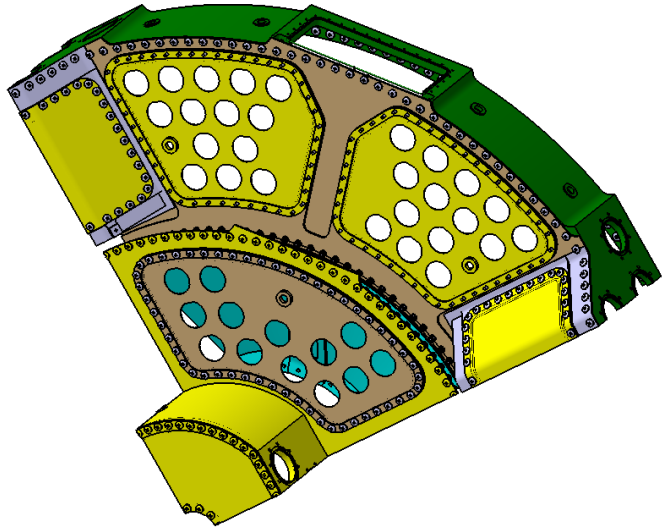
2. Calculation of the Radiation Length (Xo) – Detailed CAD Model vs. gmx – Simulation



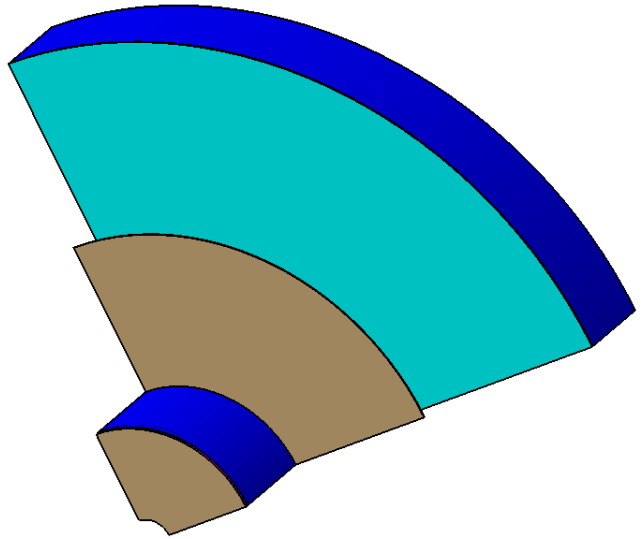
Because of geometries in each sectors are identical the Radiation length will be the same for all of them.

So, detailed calculation of the Radiation Length performed for the sector S1

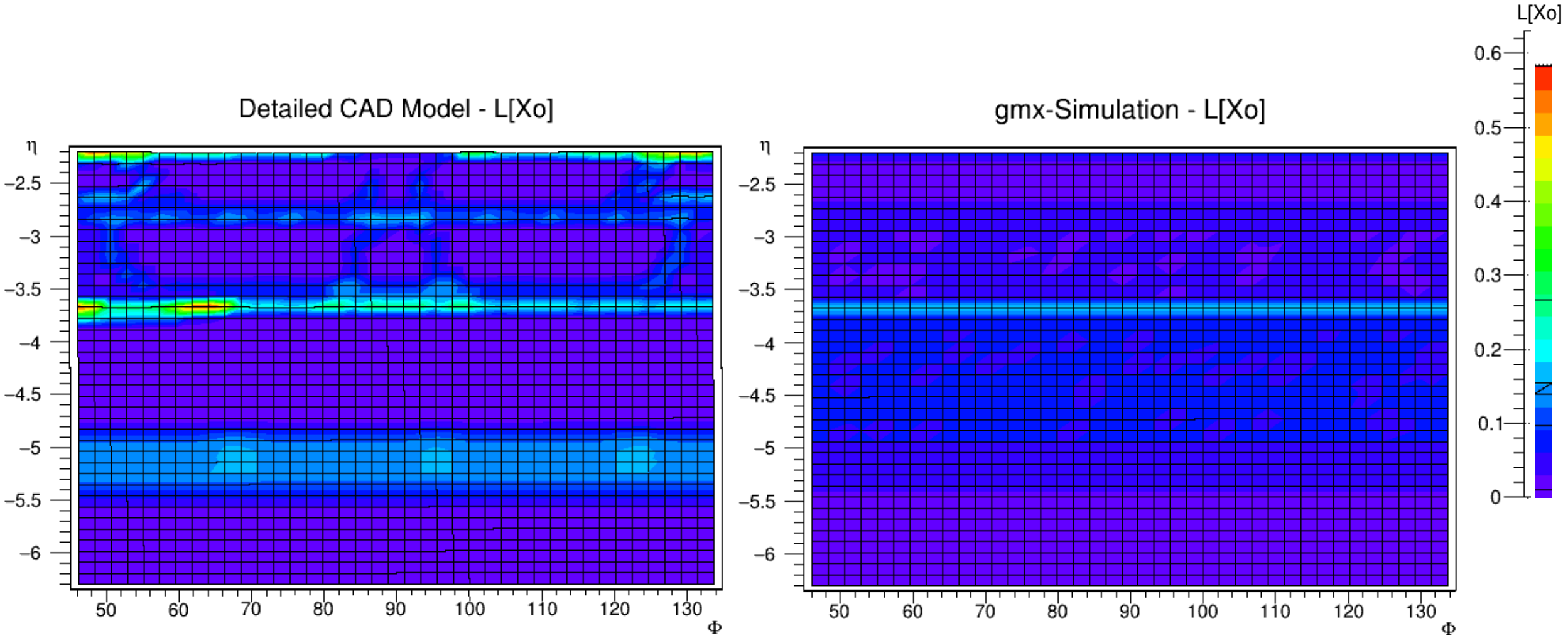
Detailed CAD model



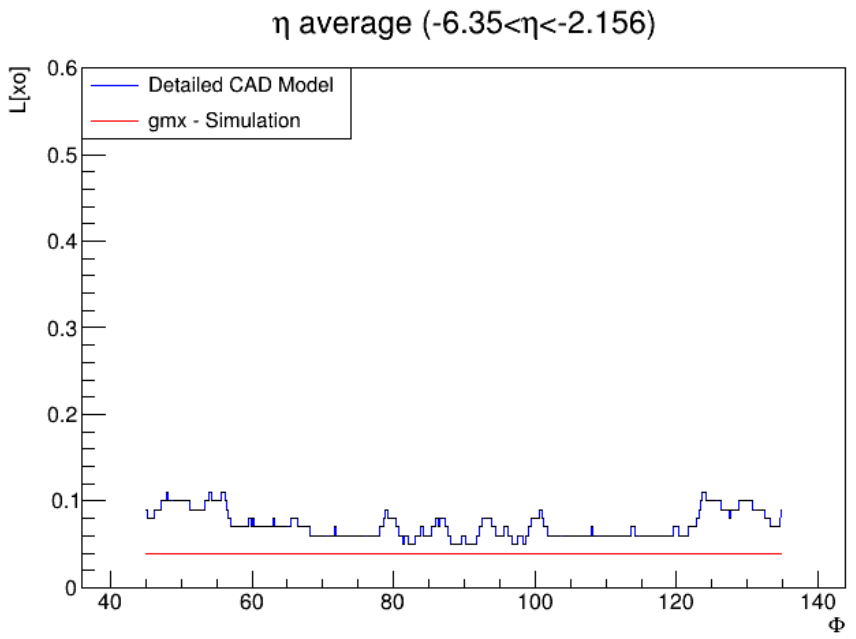
gmx - Simulation

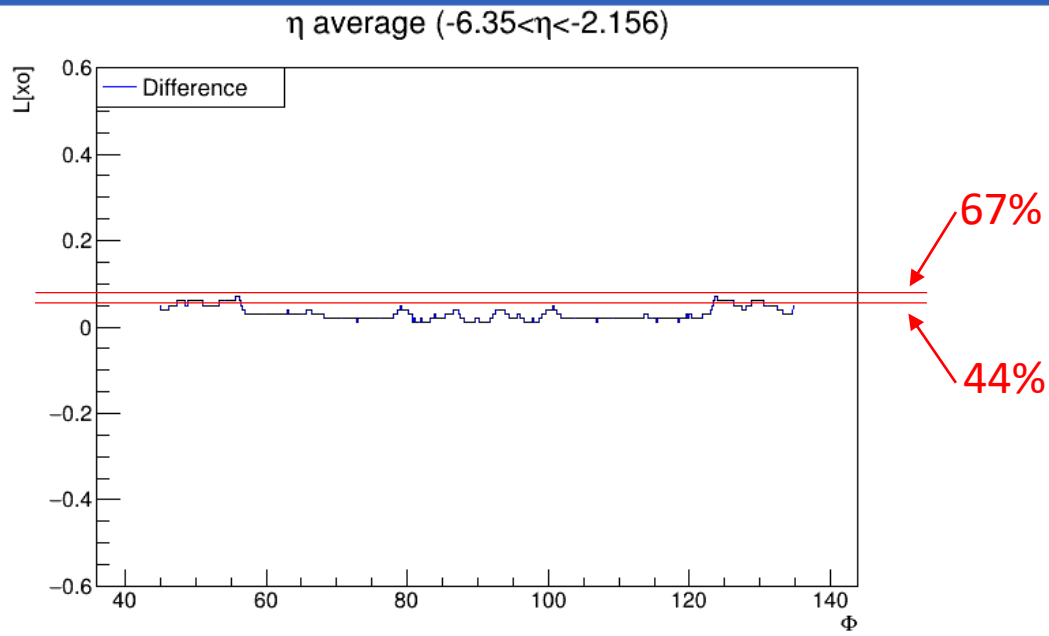


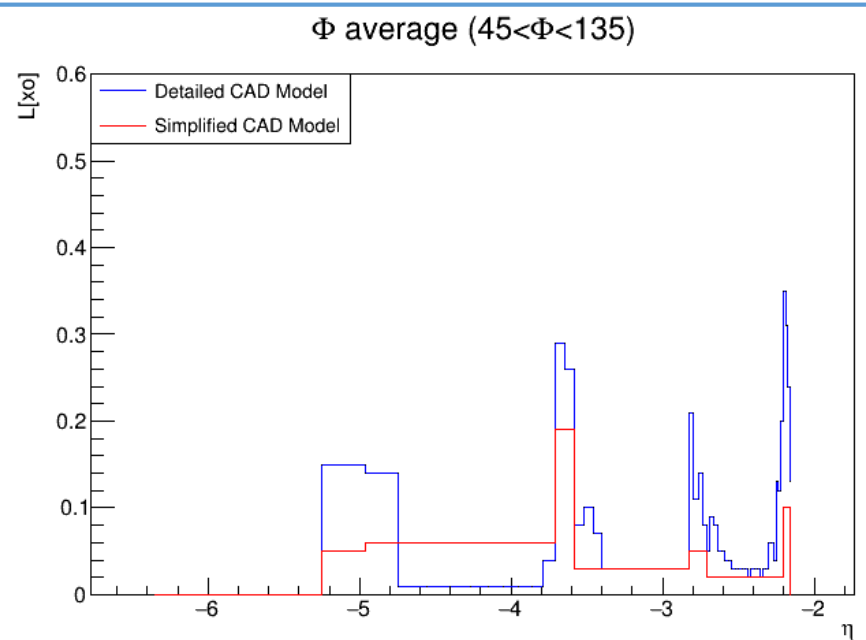
2. Calculation of the Radiation Length (Xo) – Detailed CAD Model vs. gmx – Simulation

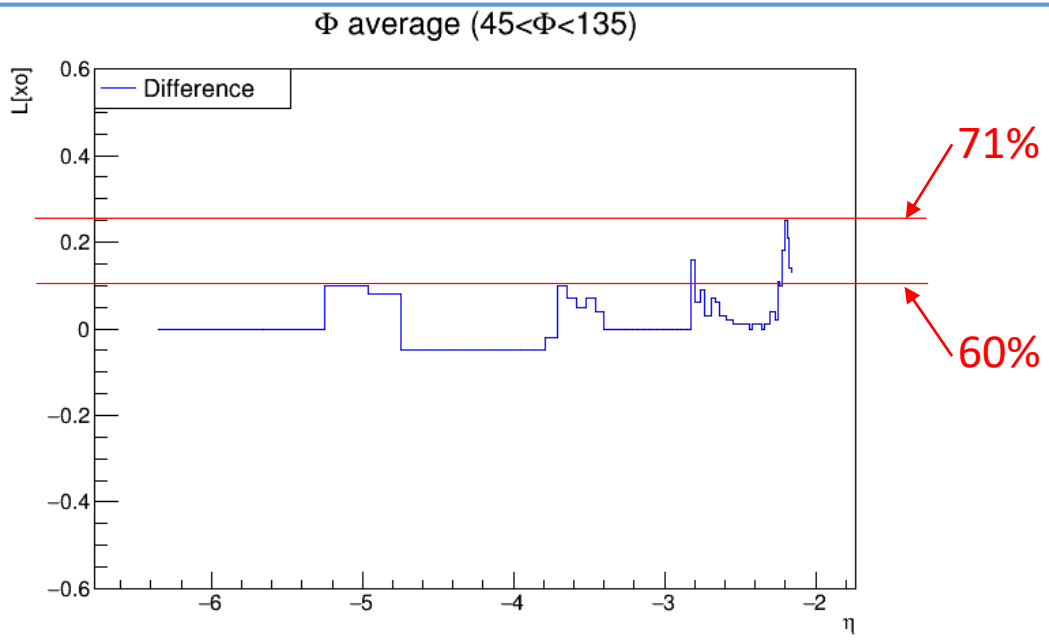


2. Calculation of the Radiation Length (Xo) - Average Values









Calculation of Radiation Length (Xo)
For Specific η / Φ

$\eta = -2.203$
$\eta = -2.685$
$\eta = -3.711$
$\eta = -5.252$

$\Phi = 48$
$\Phi = 55.2$
$\Phi = 79.6$
$\Phi = 124.4$

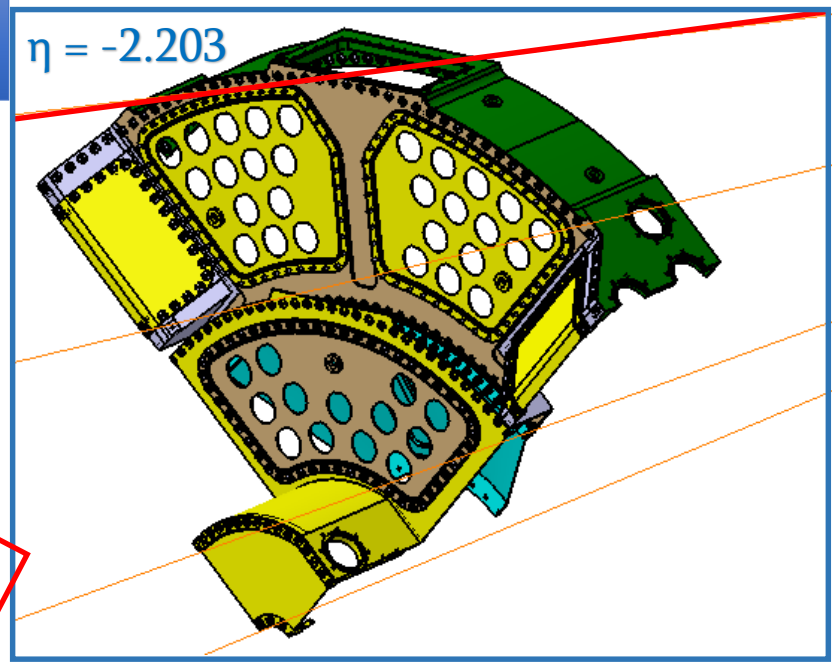
$45 < \Phi < 135$

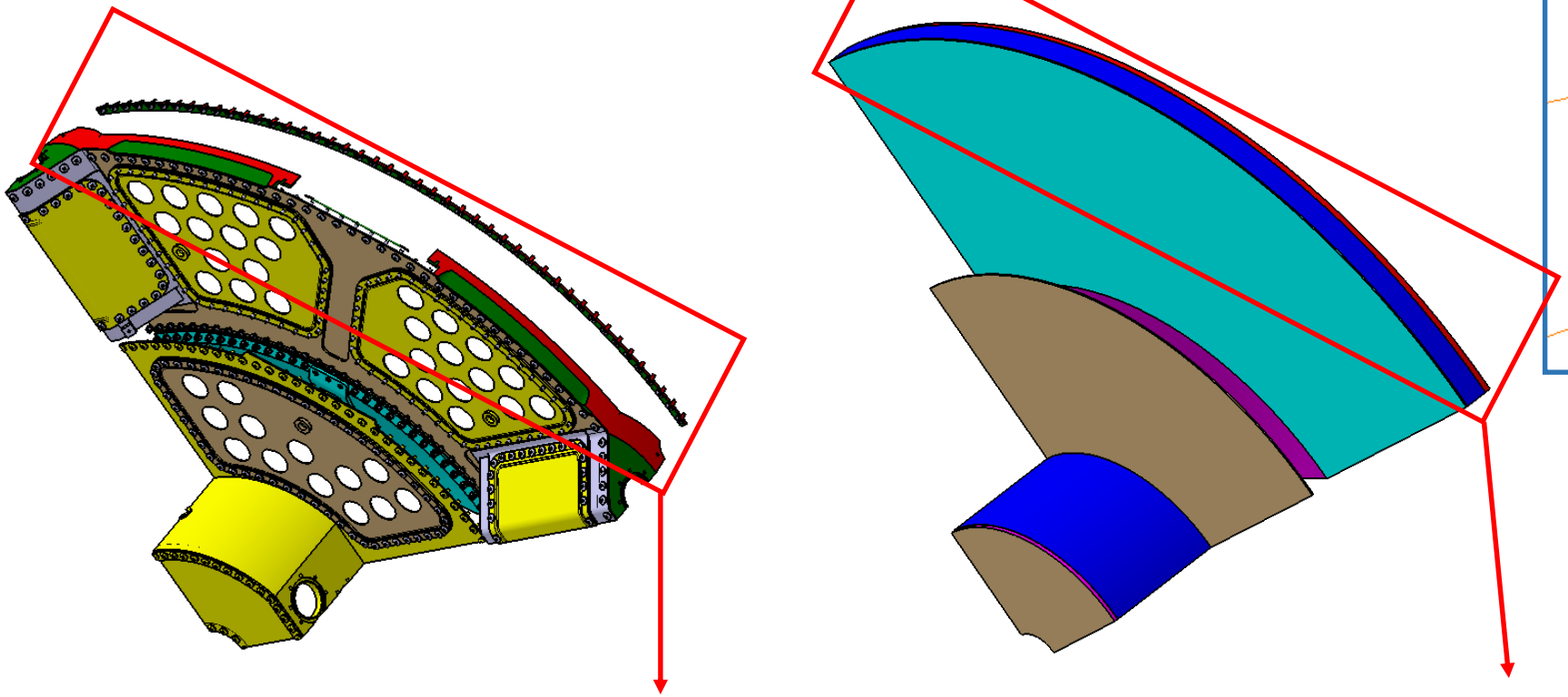
$-6.35 < \eta < -2.156$

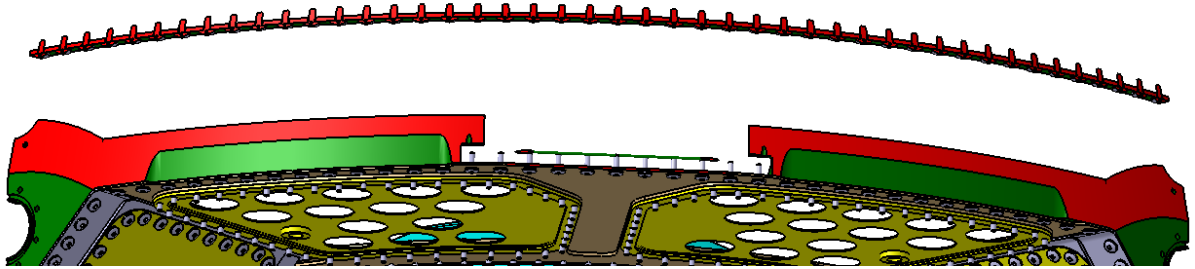
2. Calculation of the Radiation Length (Xo) – η = -2.203

Detailed CAD Model

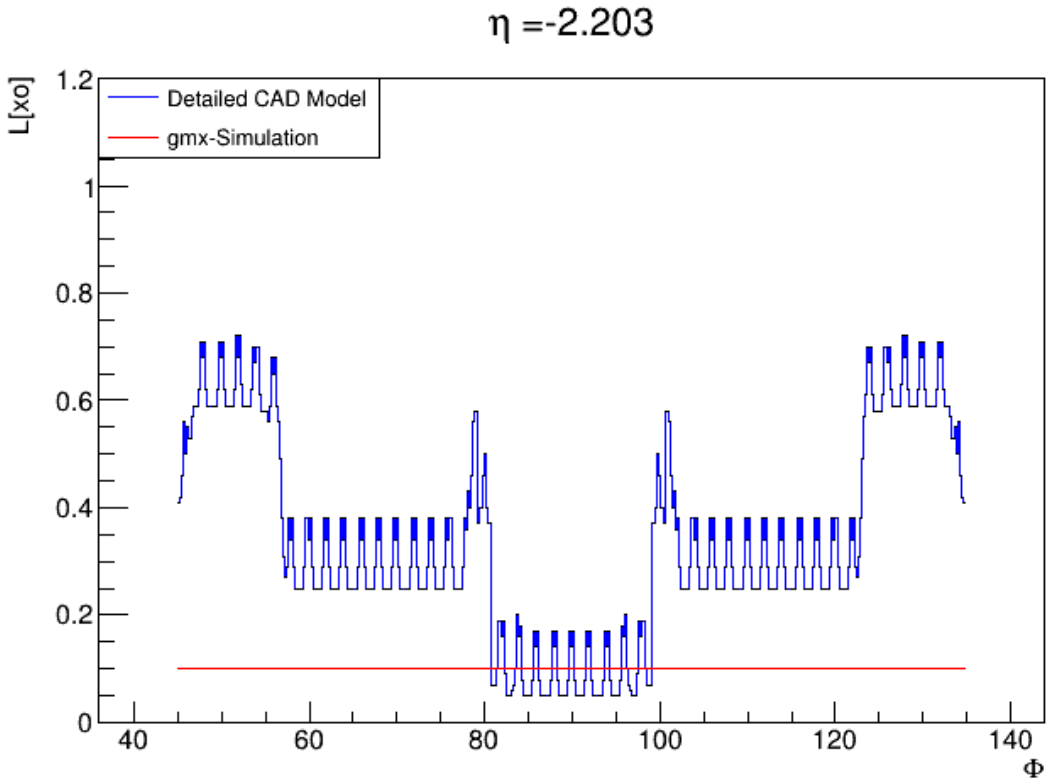
gmx - Simulation

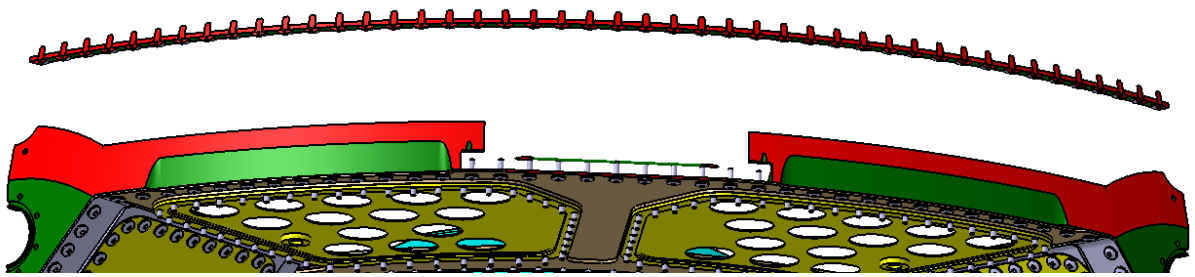


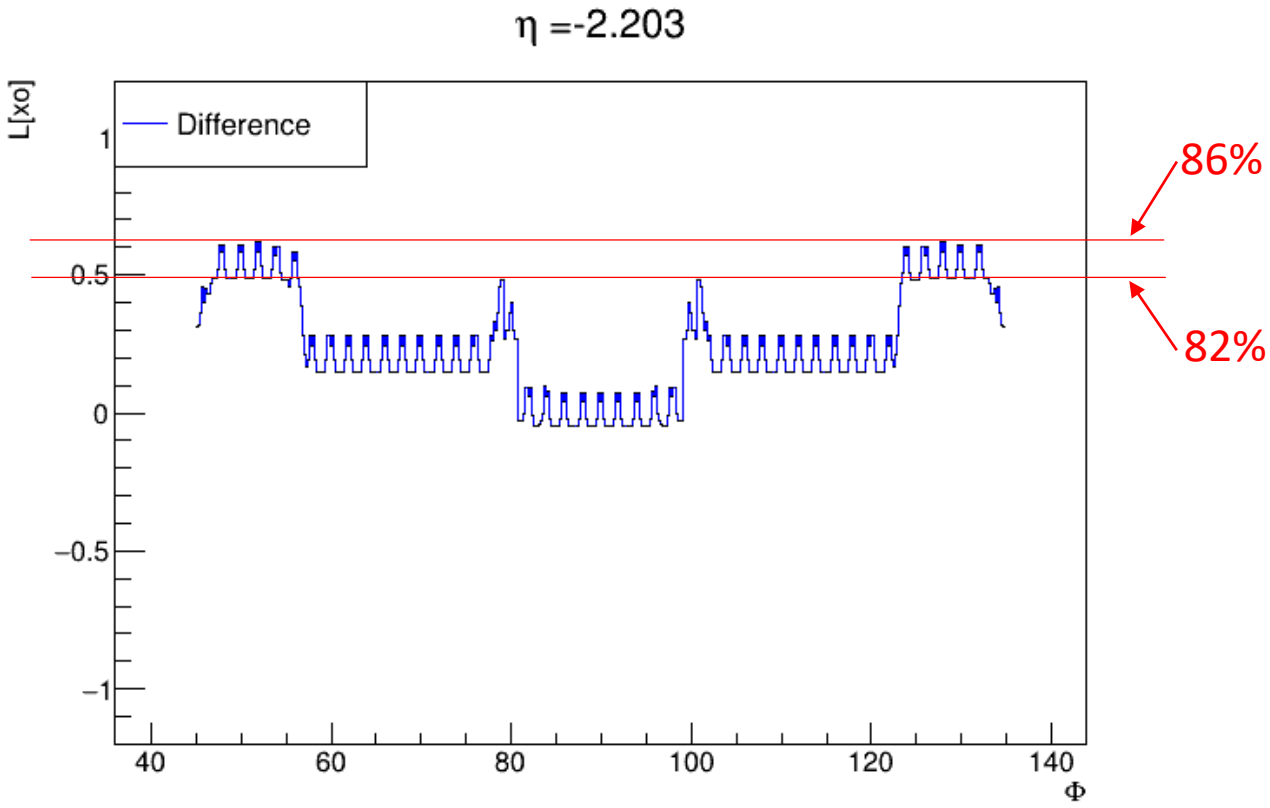




2. Calculation of the Radiation Length (Xo) – η = -2.203



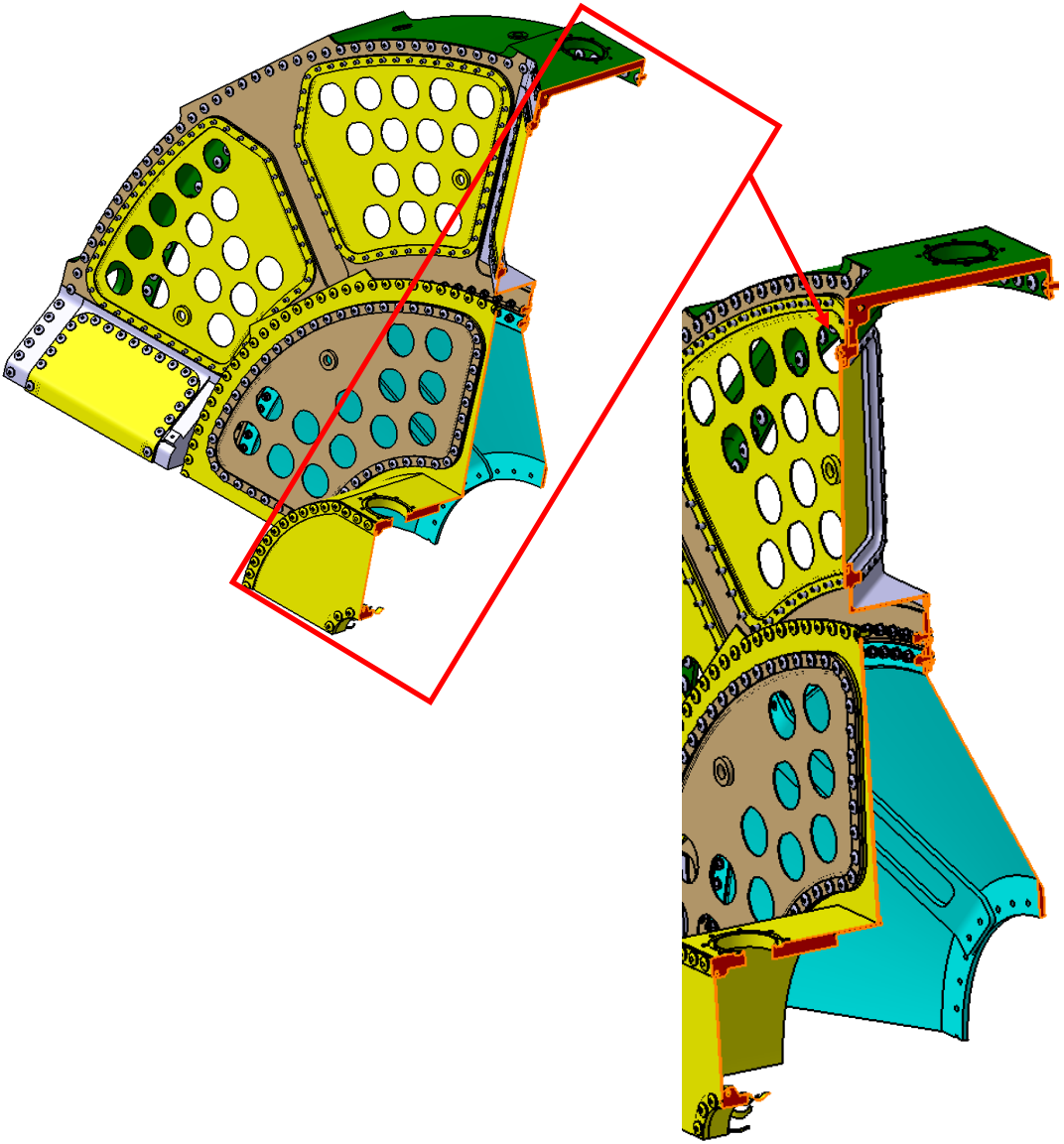


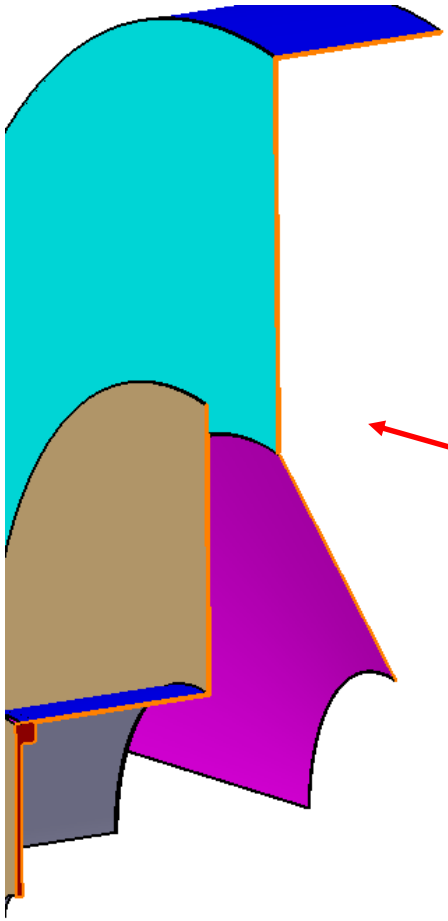


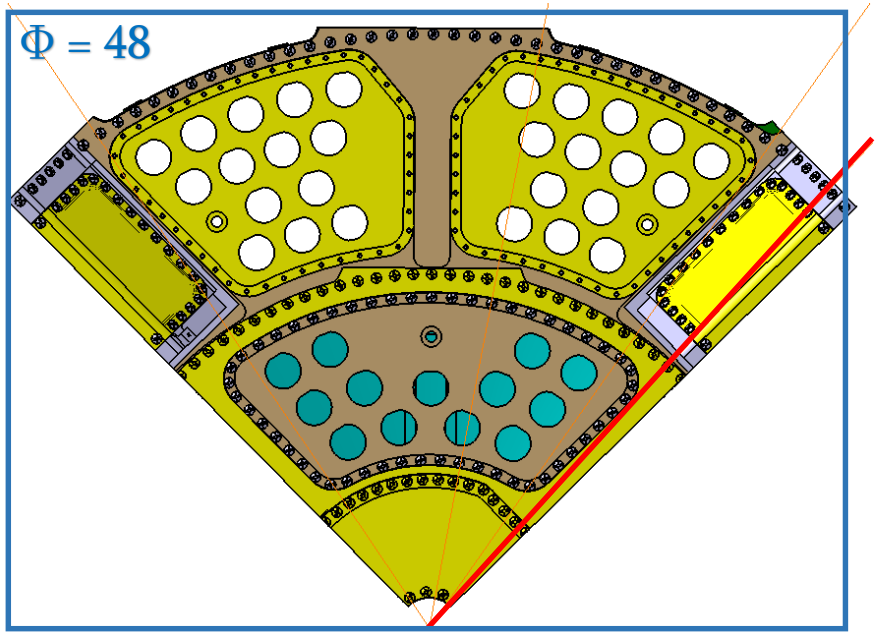
2. Calculation of the Radiation Length (Xo) – Φ= 48

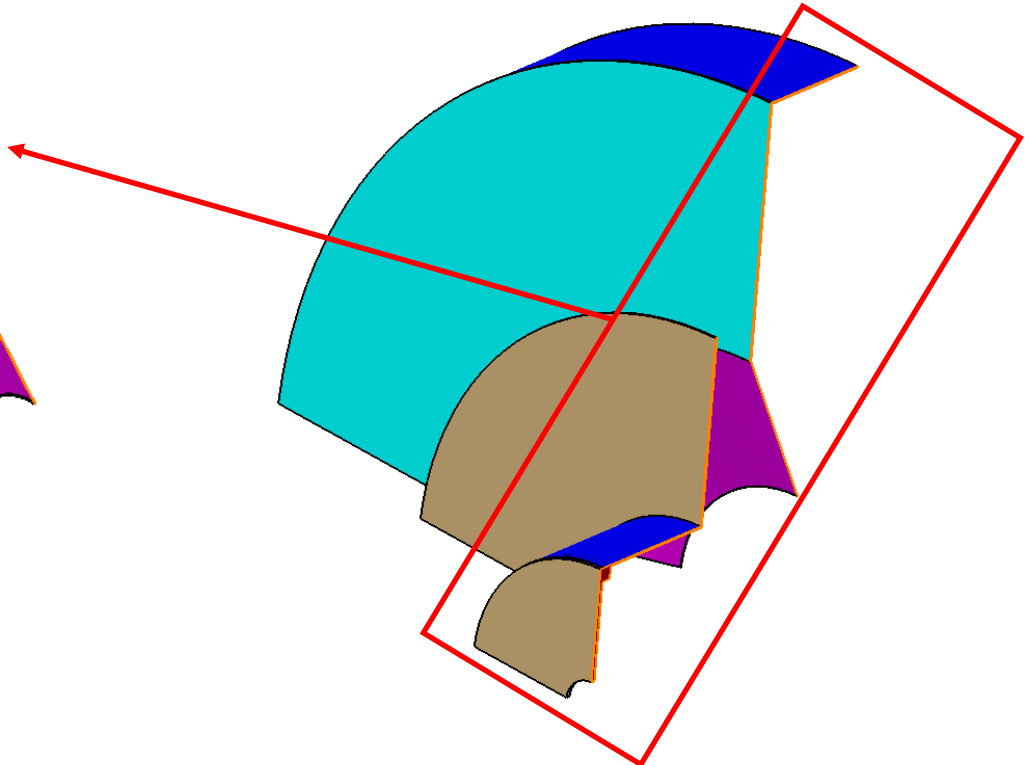
Detailed CAD Model

gmx - Simulation

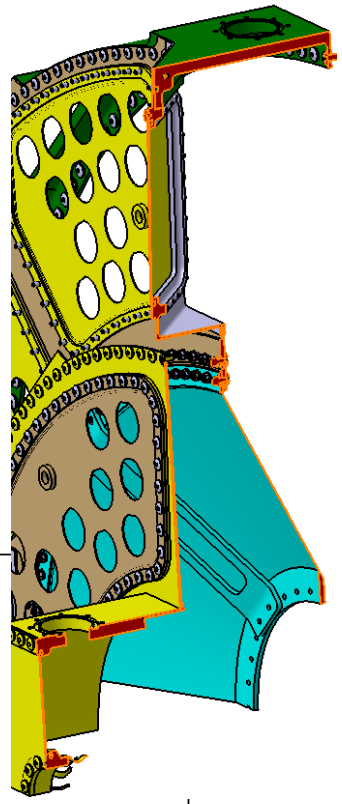


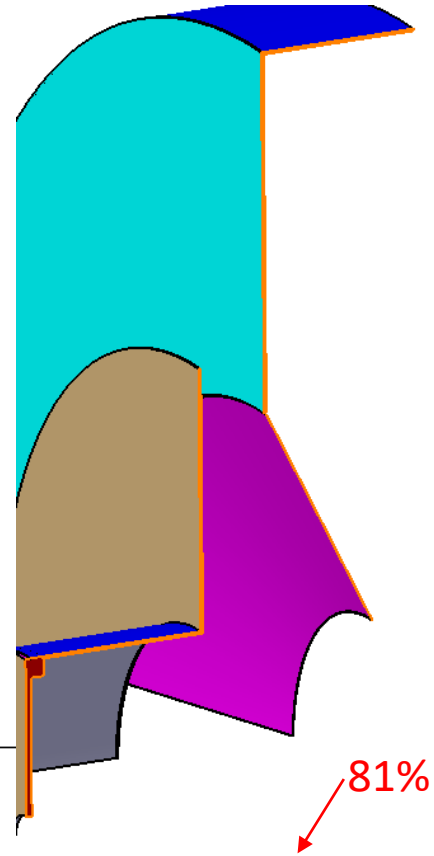


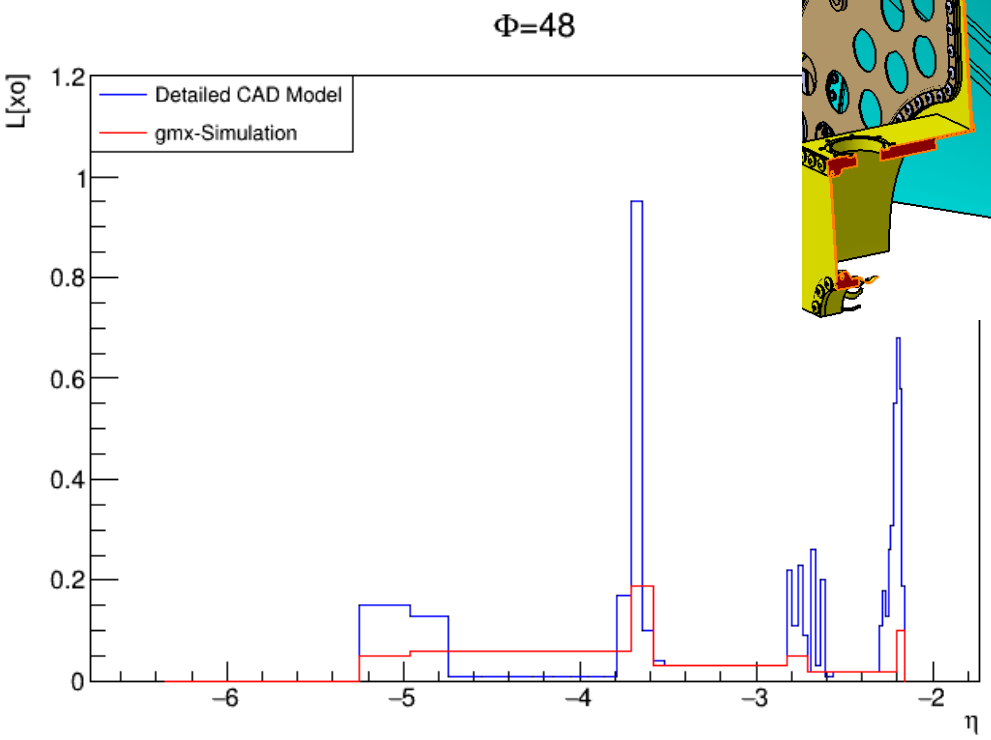


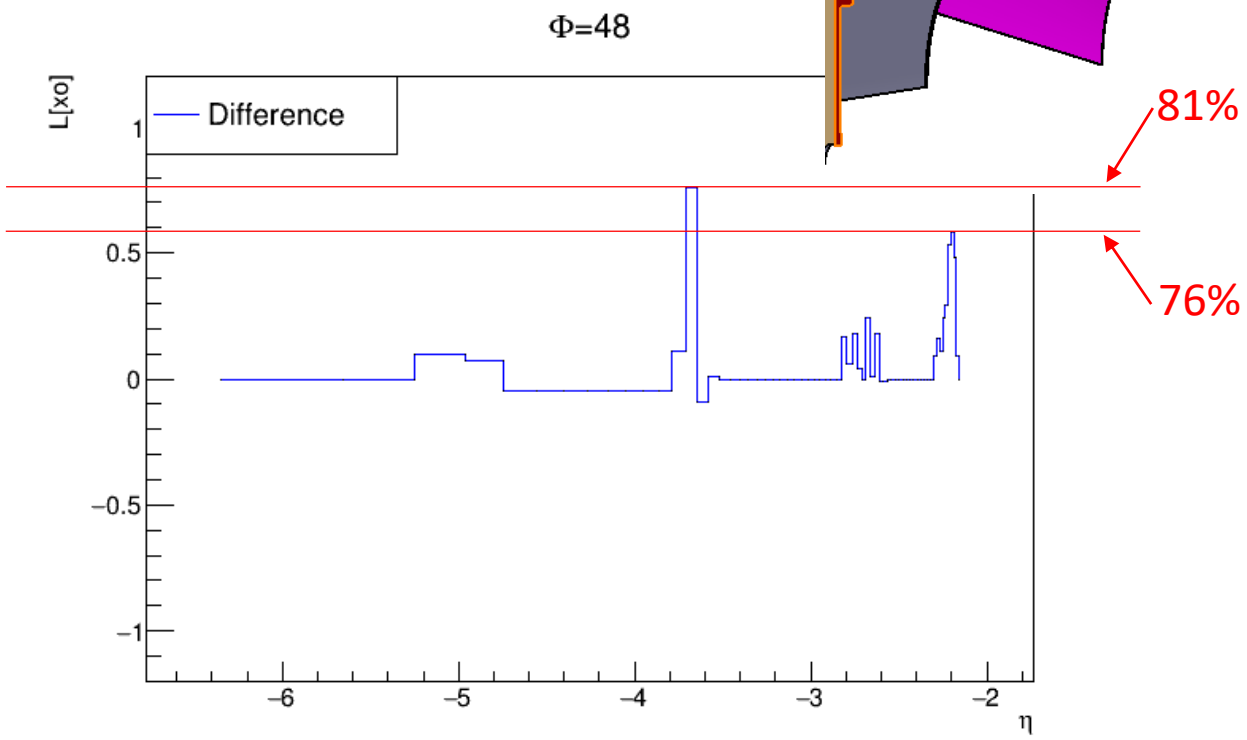


2. Calculation of the Radiation Length (Xo) - Φ= 48





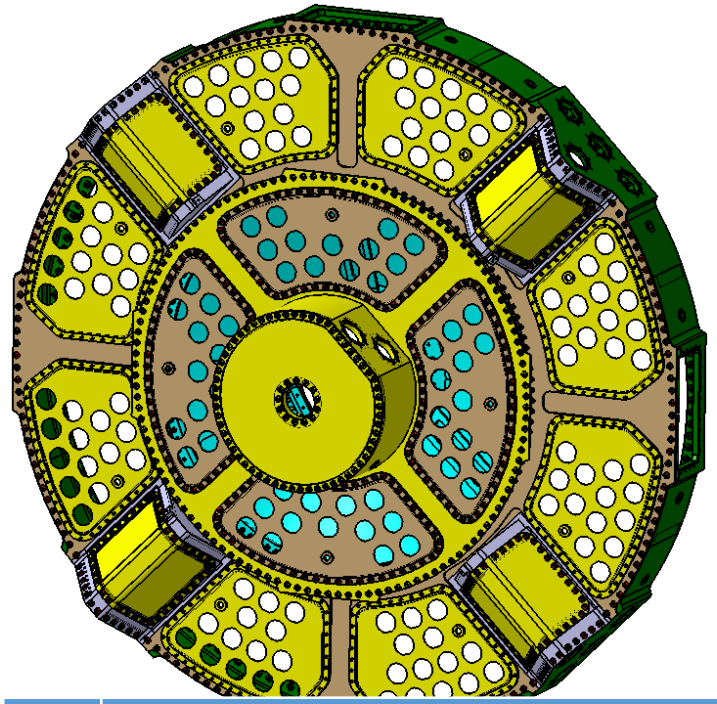




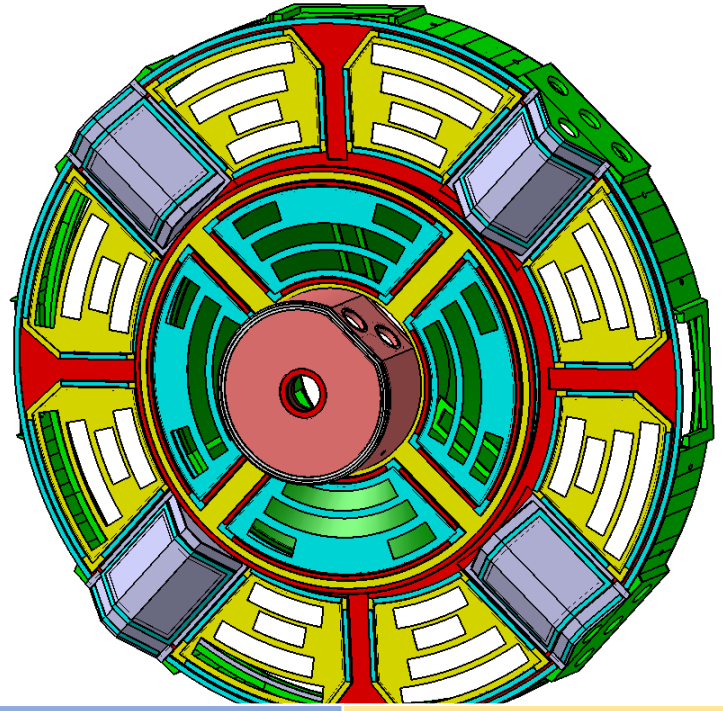
3. Simplification of the Detailed CAD Model

3. Simplification of the Detailed CAD Model

Detailed Model



Simplified Model



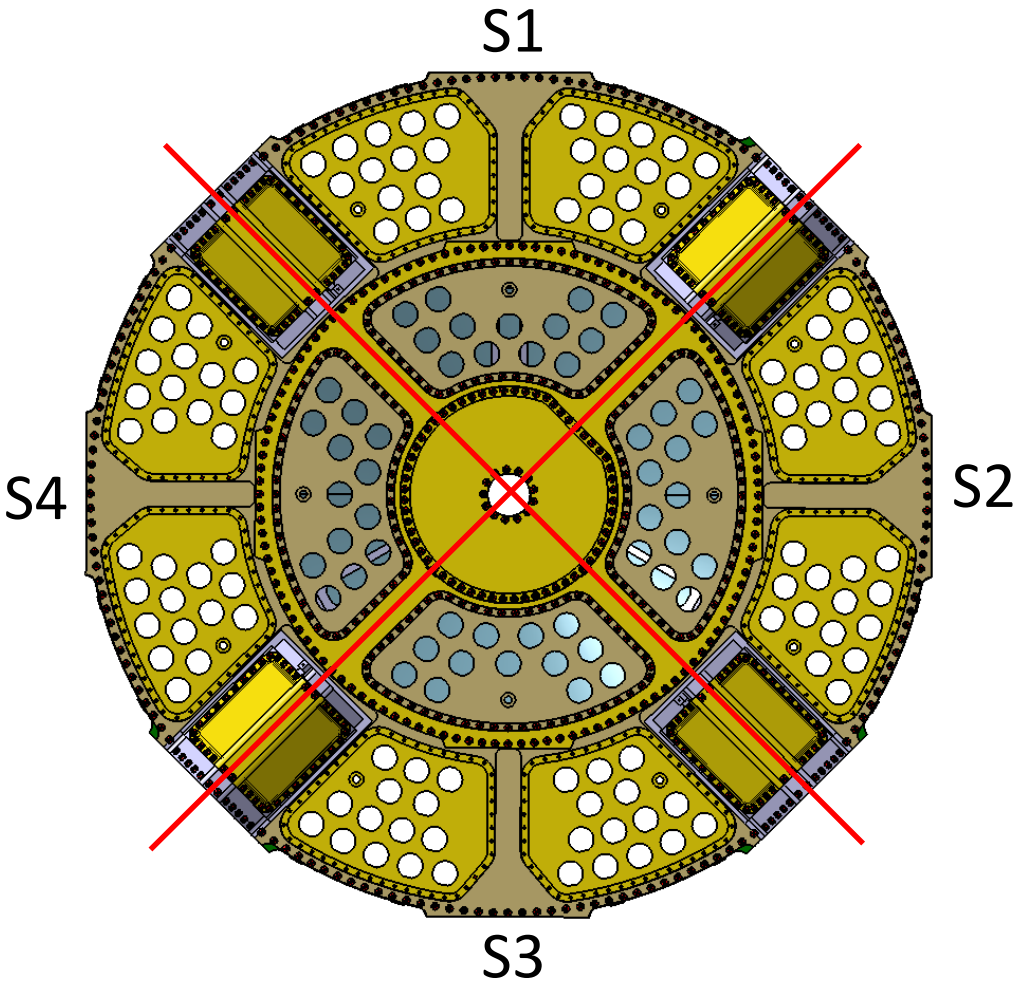
		Detailed Model		Simplified Model	
N	Name	Volume (m^3)	Weight (kg)	Volume (m^3)	Weight (kg)
1	Outer Patch Panel, Cooling Housing, Outer Wall, Bolts	0.00383	10.3	0.00383	10.3
2	PP1_Inner Wall, Inner Patch Panel, Bolts	0.001075	2.9	0.001087	2.92
3	PP1_Inner Wall, Closing Flange, PP1 Inner Cylinder, IPT Interface Flange, Bolts	0.00084	2.26	0.00084	2.26
4	Inner Wall, Closing Flange, PP1 Inner Cylinder, IPT Interface Flange, Bolts	0.006004	16.16	0.006004	16.16
	Total:	**0.011749**	**31.62**	**0.011761**	**31.64**

Diff. 0.02 kg

4. Calculation of the Radiation Length (Xo)

Detailed CAD Model vs. Simplified CAD Model

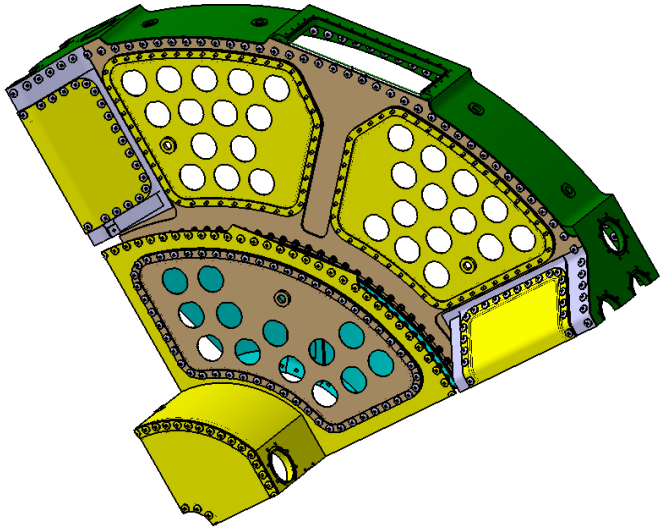
4. Calculation of the Radiation Length (Xo) – Detailed CAD Model vs. Simplified CAD Model



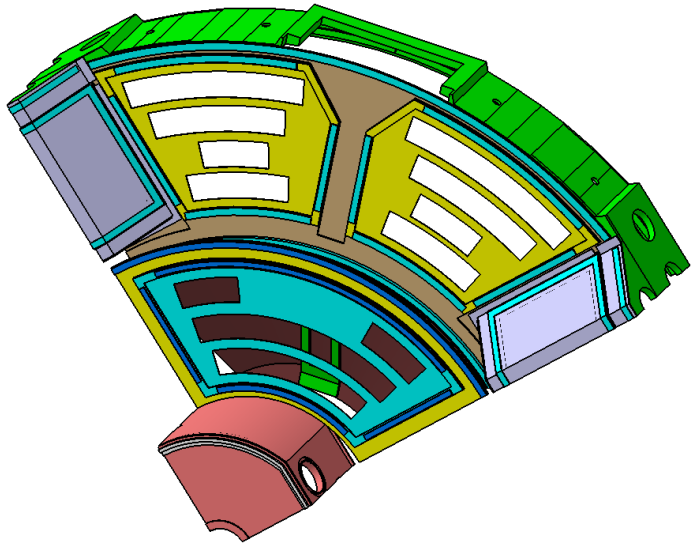
Because of geometries in each sectors are identical the Radiation length will be the same for all of them.

So, detailed calculation of the Radiation Length performed for the sector S1

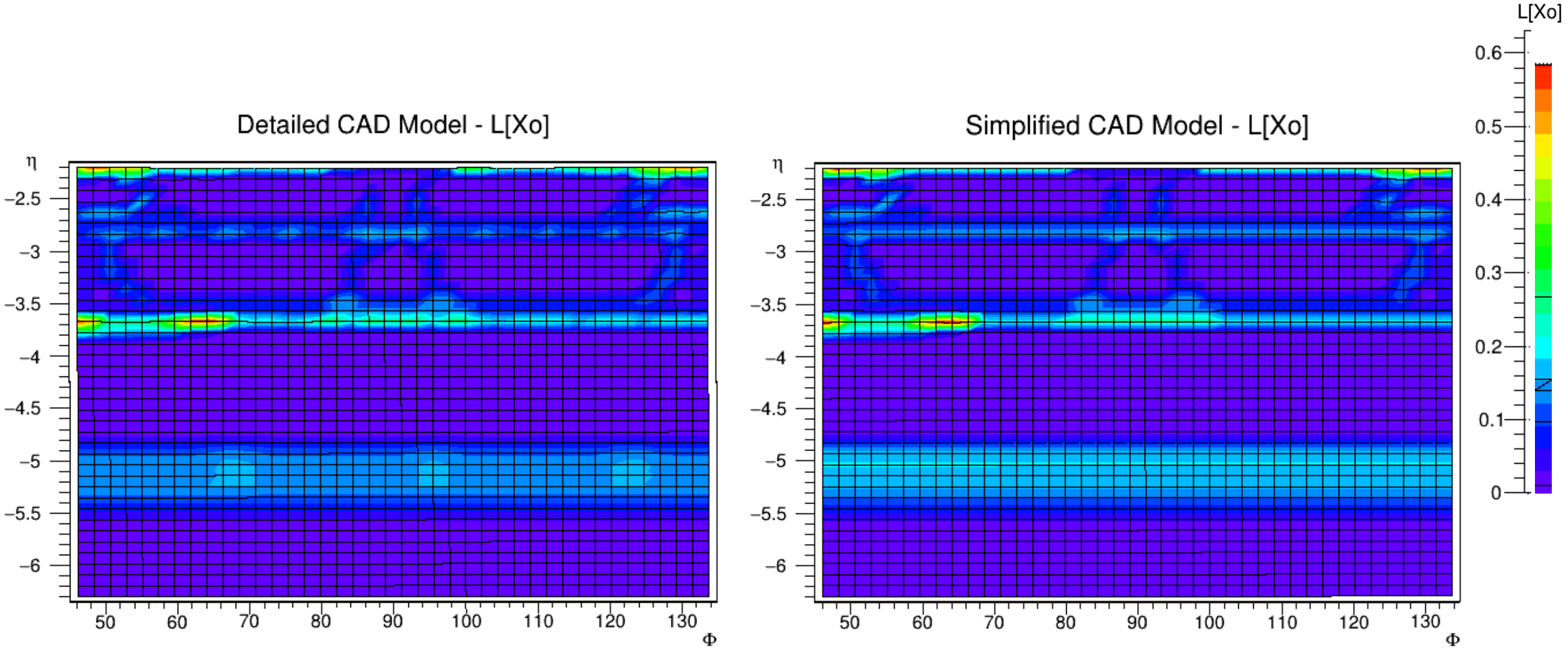
Detailed CAD model



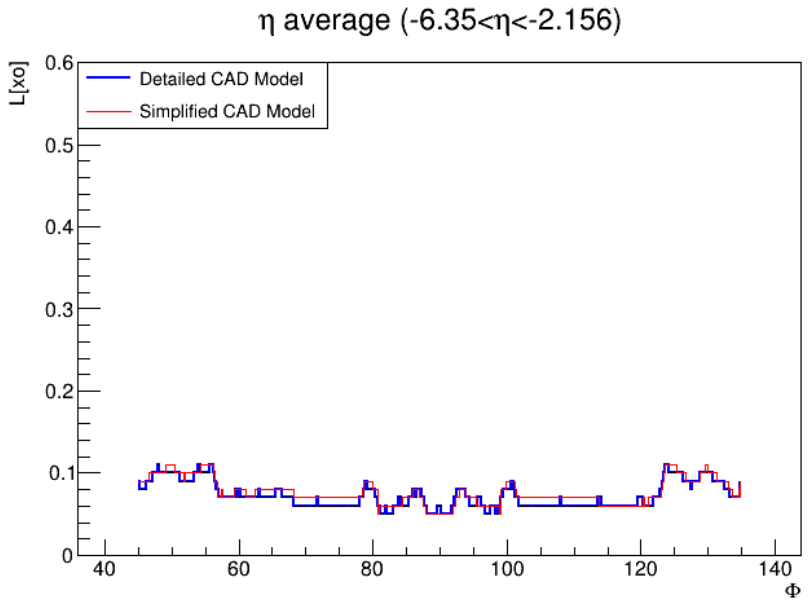
Simplified CAD Model

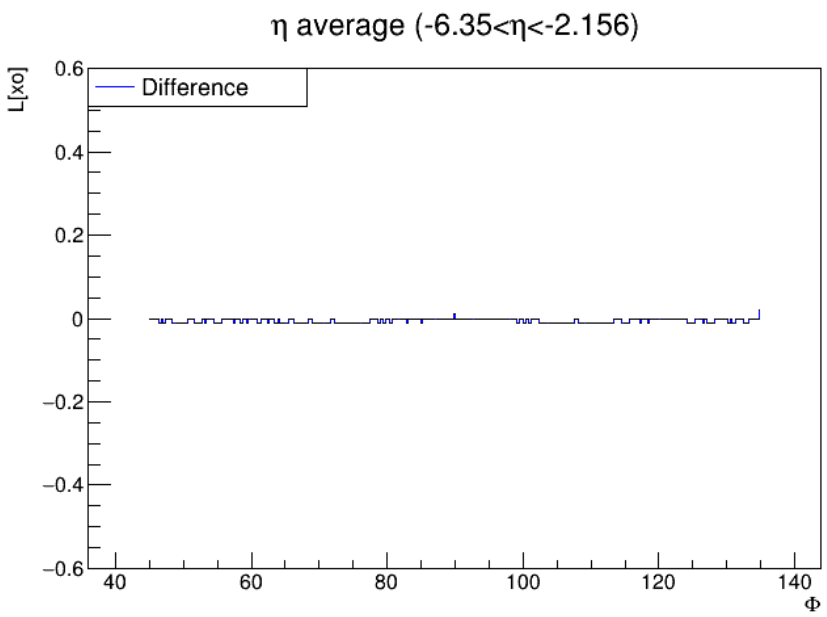


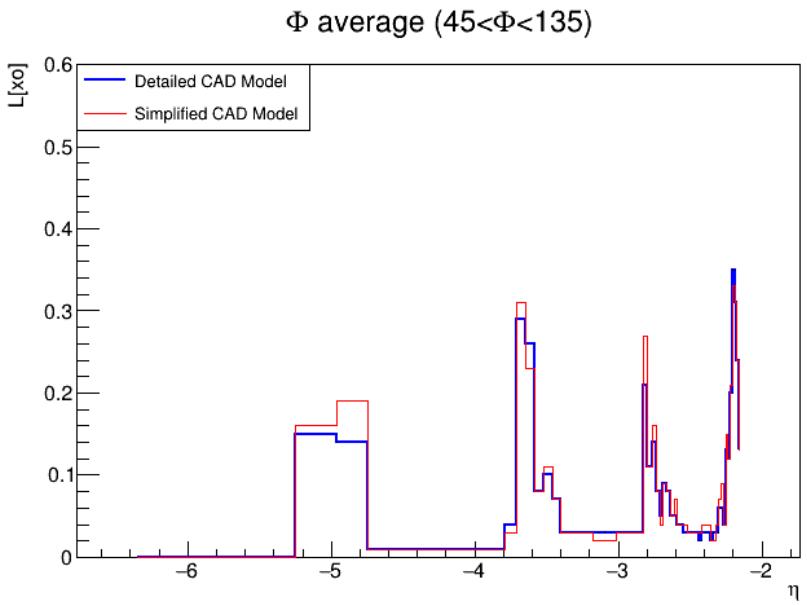
4. Calculation of the Radiation Length (Xo) – Detailed CAD Model vs. Simplified CAD Model

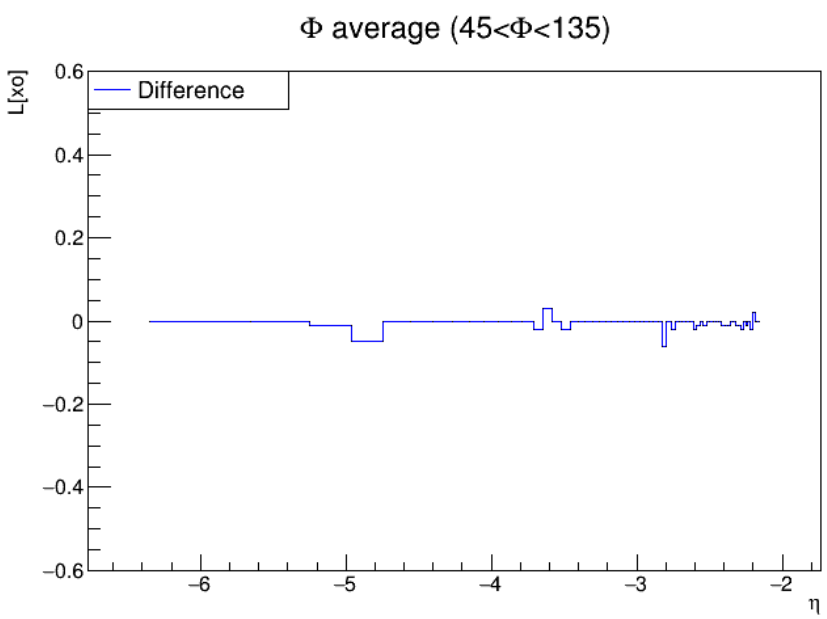


4. Calculation of the Radiation Length (Xo) - Average Values









Calculation of Radiation Length (Xo)
For Specific η / Φ

$\eta = -2.203$
$\eta = -2.685$
$\eta = -3.711$
$\eta = -5.252$

$\Phi = 48$
$\Phi = 55.2$
$\Phi = 79.6$
$\Phi = 124.4$

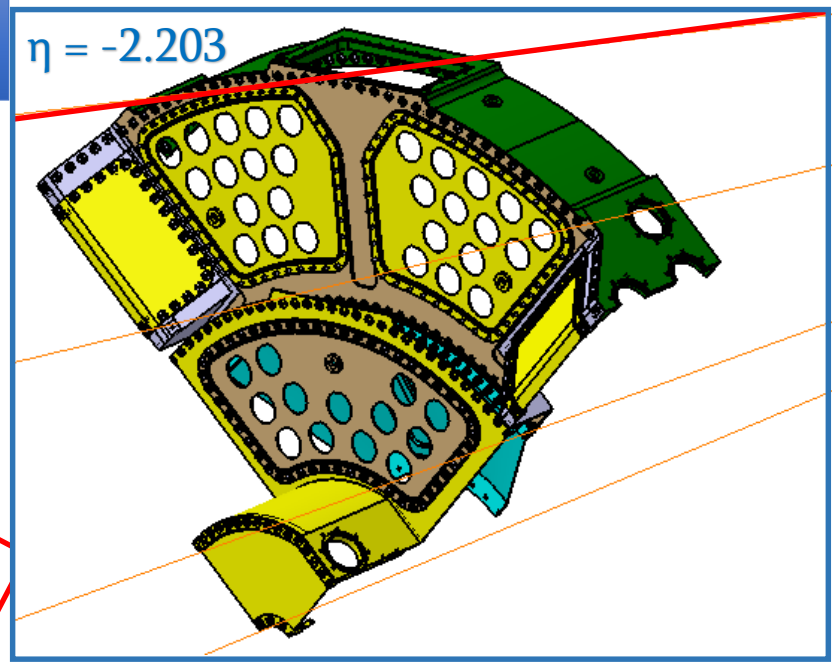
$45 < \Phi < 135$

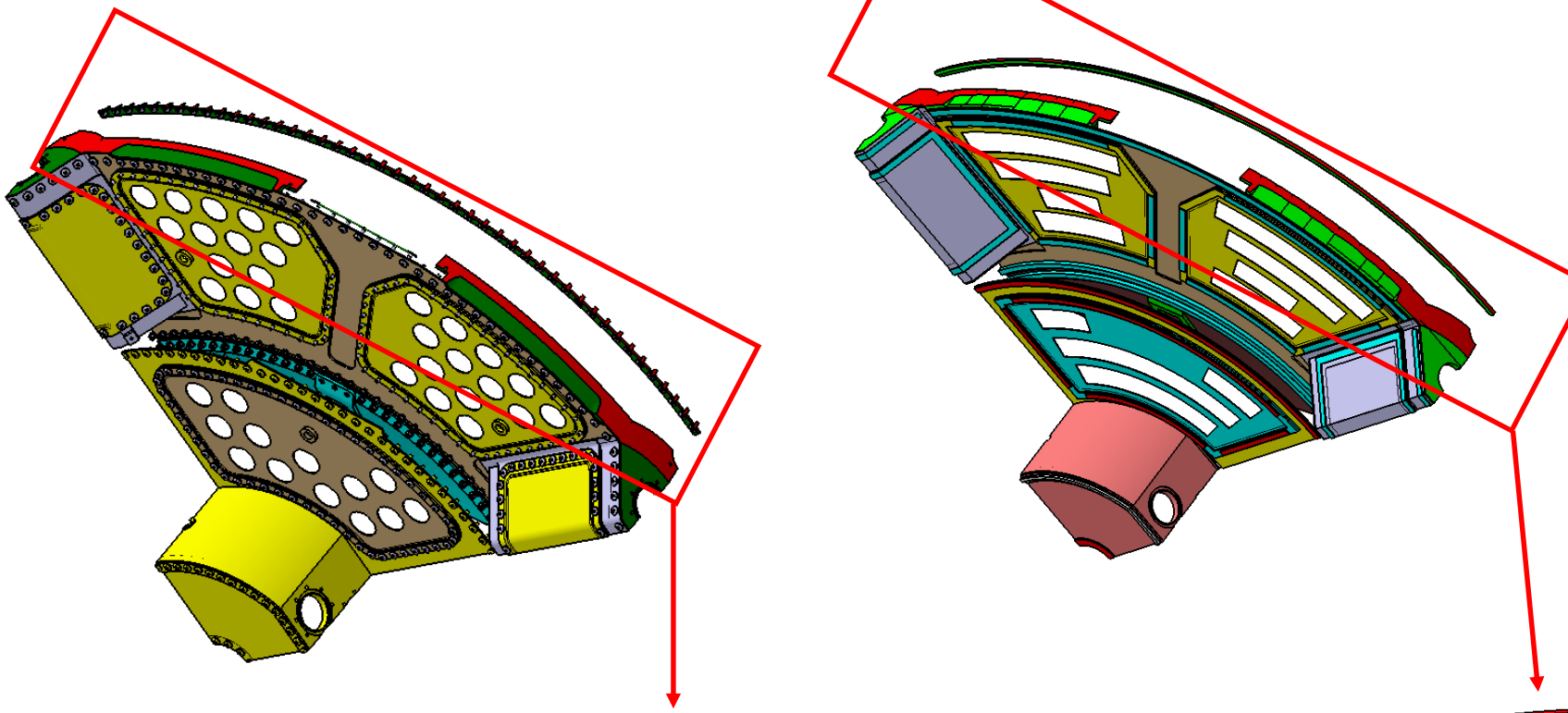
$-6.35 < \eta < -2.156$

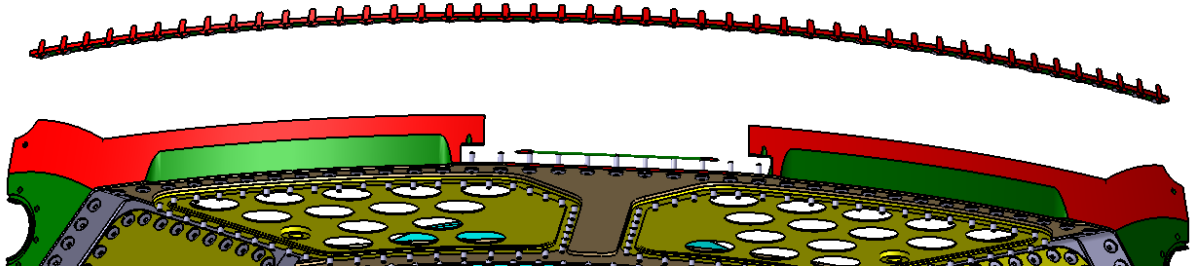
4. Calculation of the Radiation Length (Xo) – η = -2.203

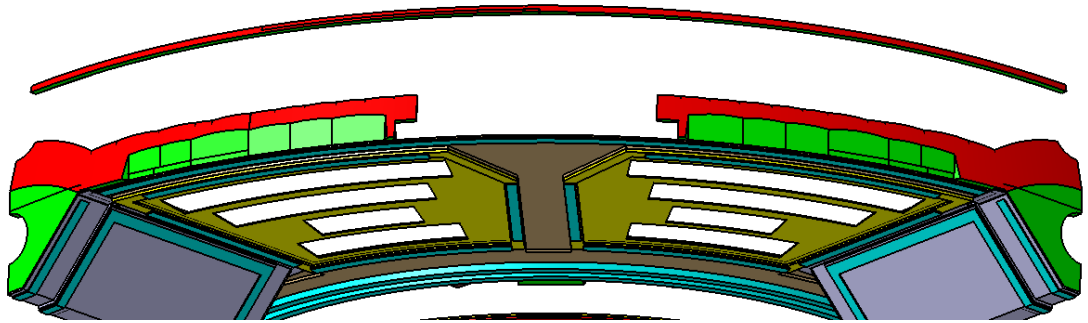
Detailed CAD Model

Simplified model

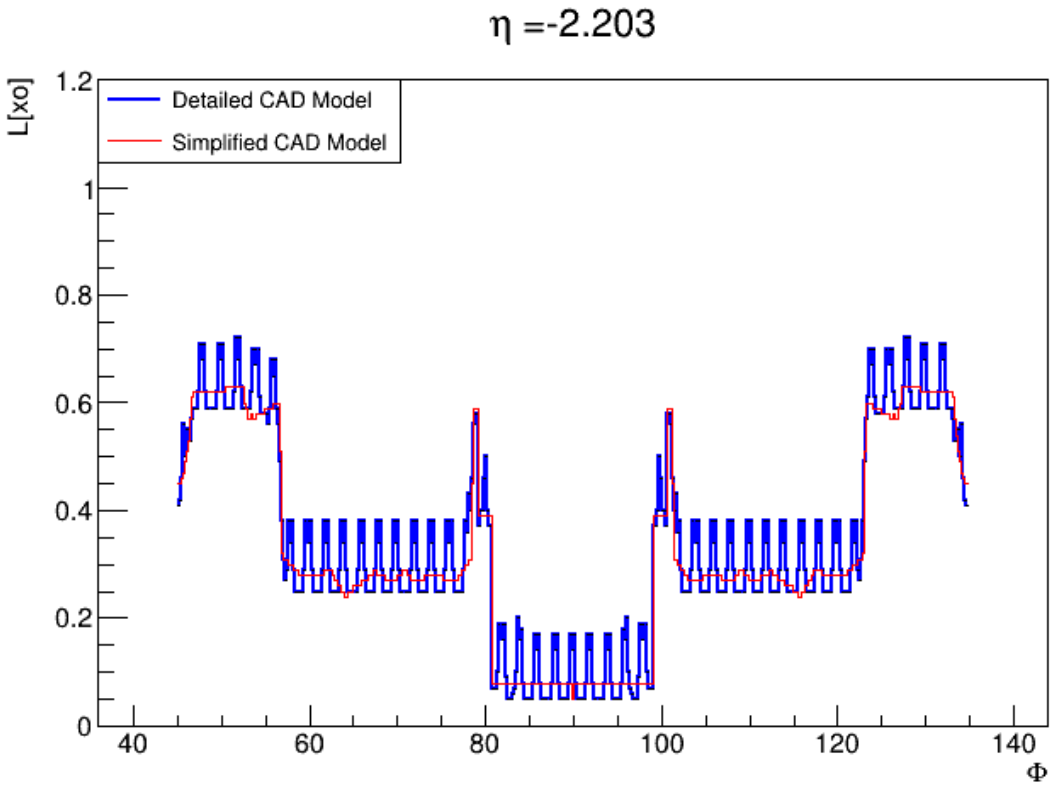


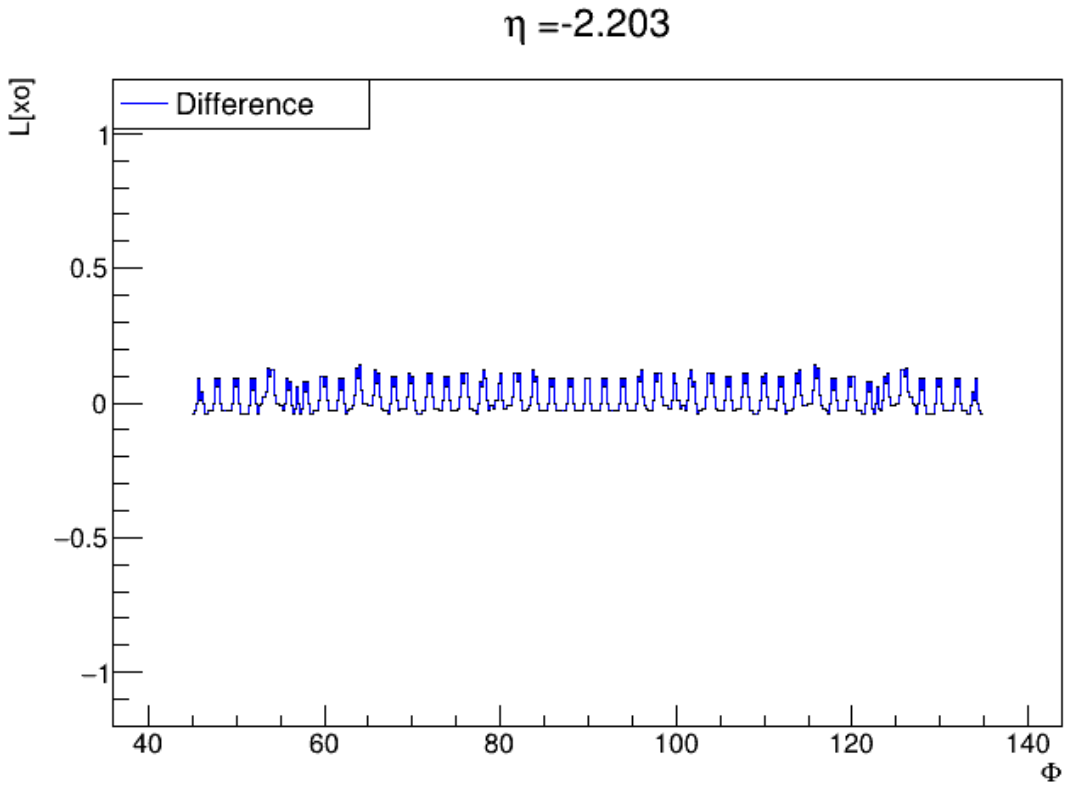


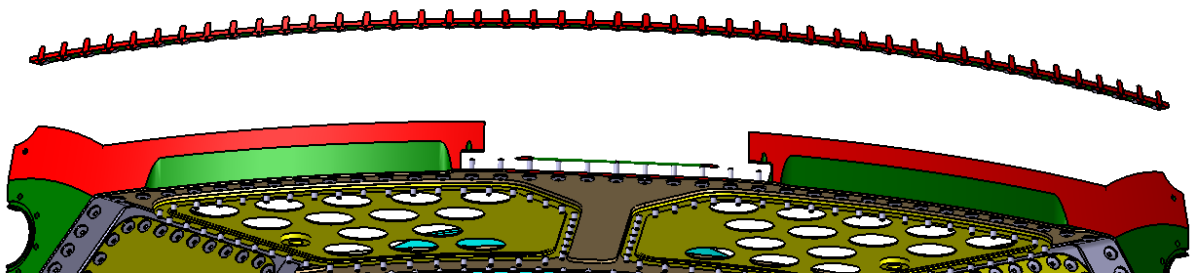


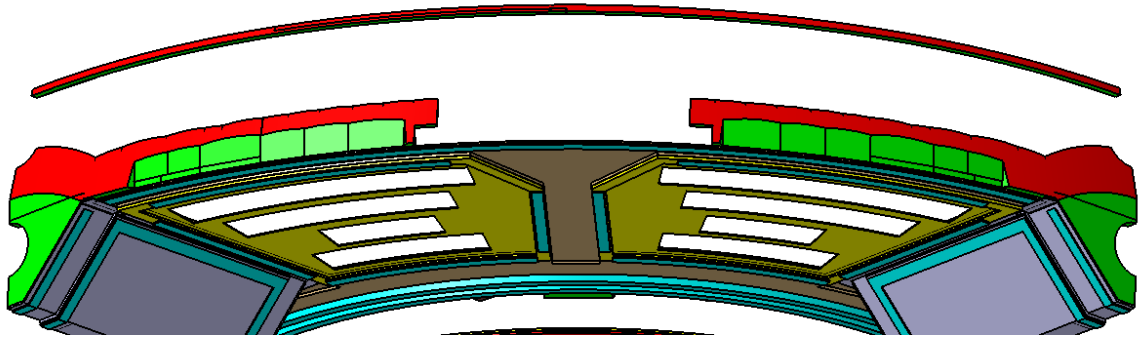


4. Calculation of the Radiation Length (Xo) – η = -2.203



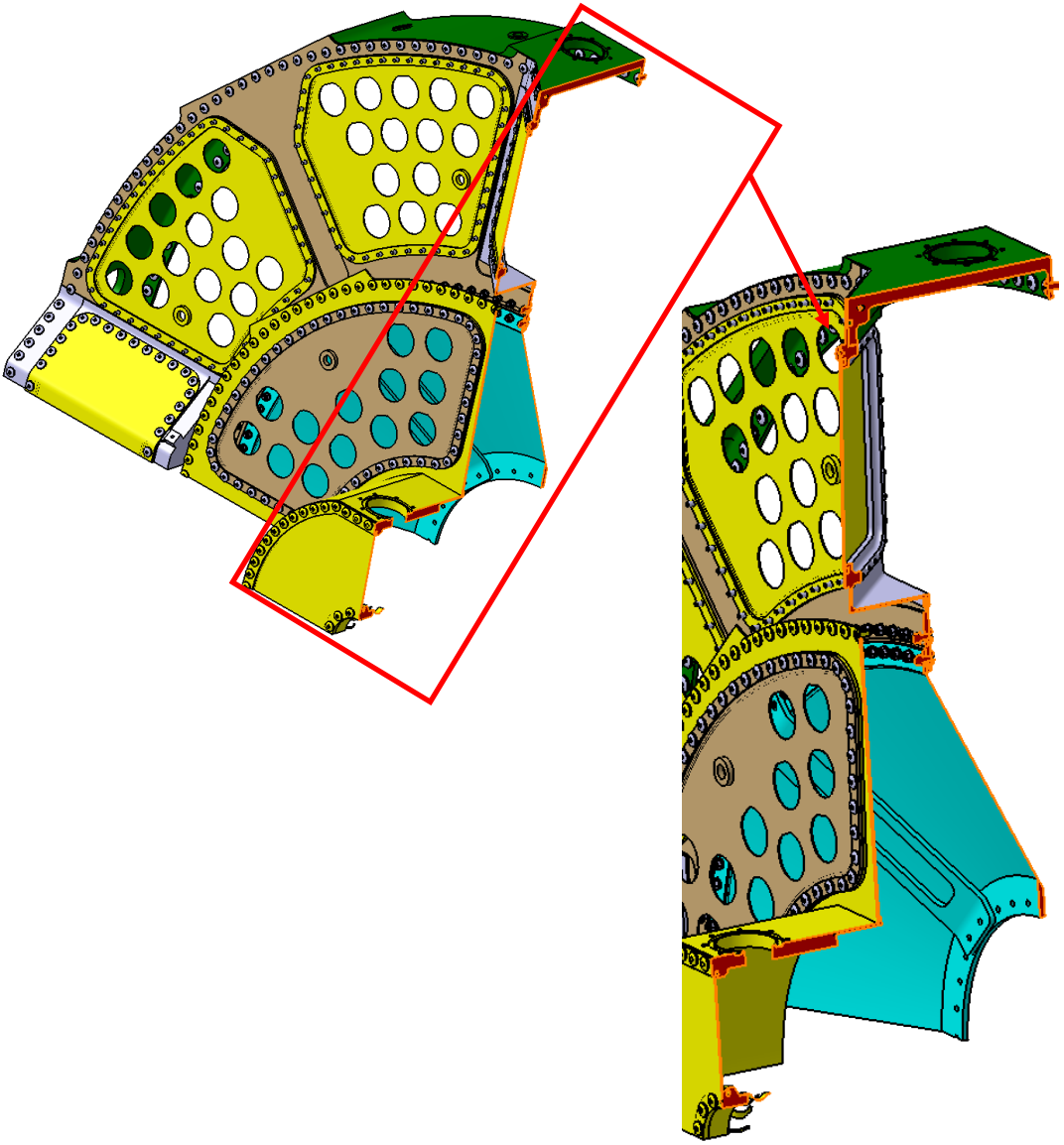




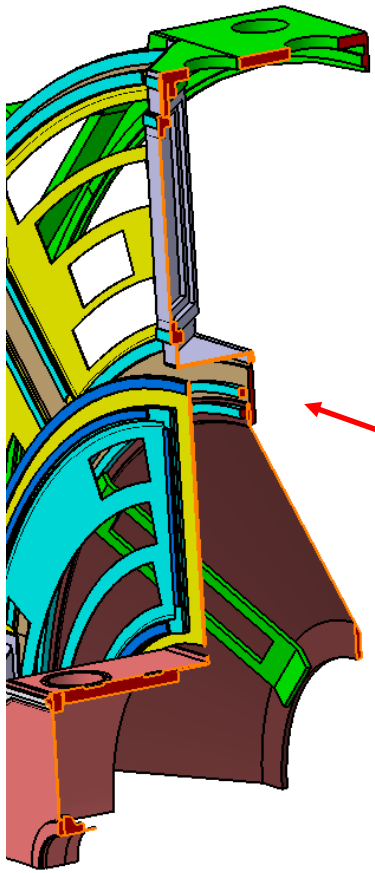


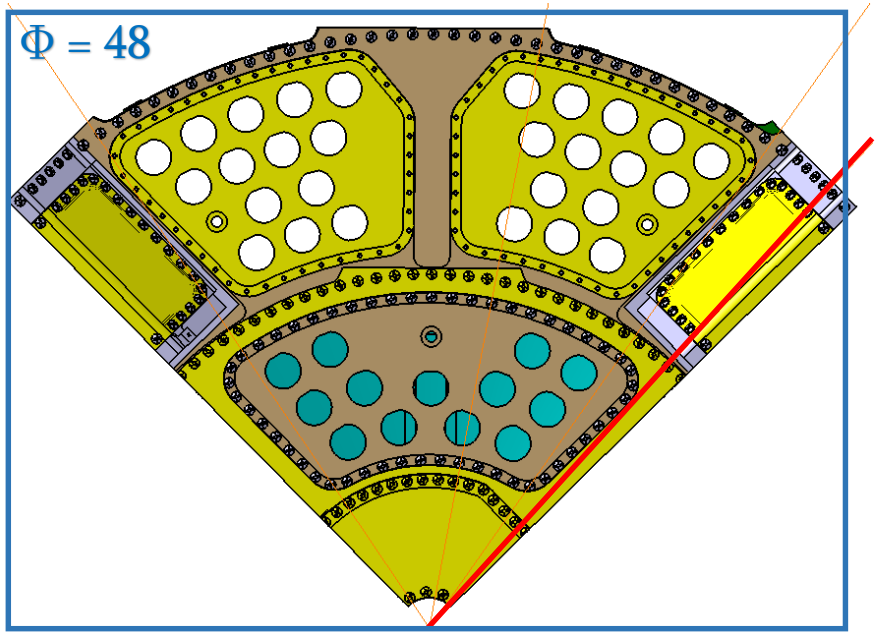
4. Calculation of the Radiation Length (Xo) - Φ = 48

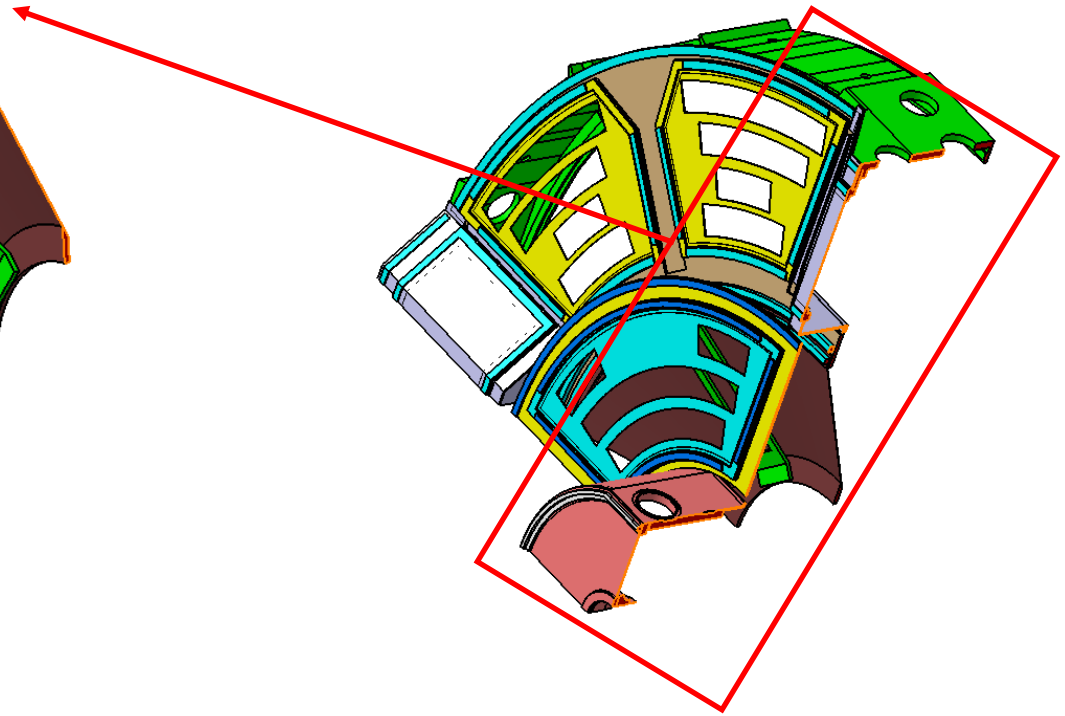
Detailed CAD Model



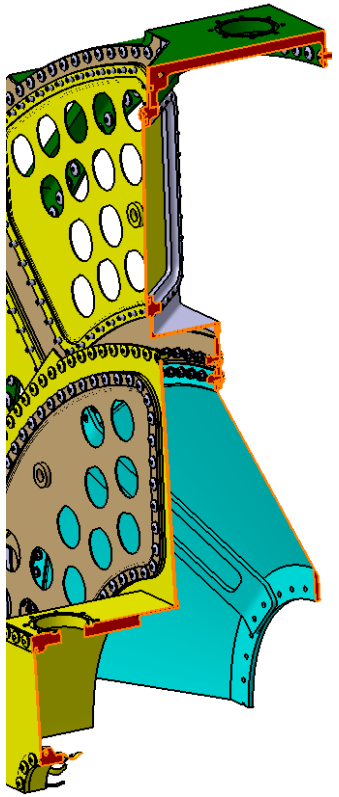
Simplified model

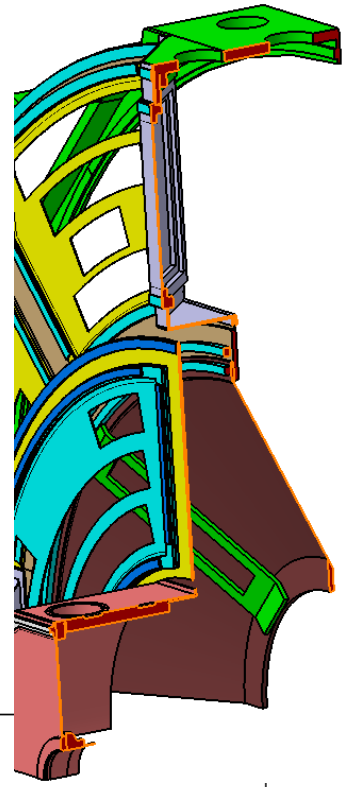


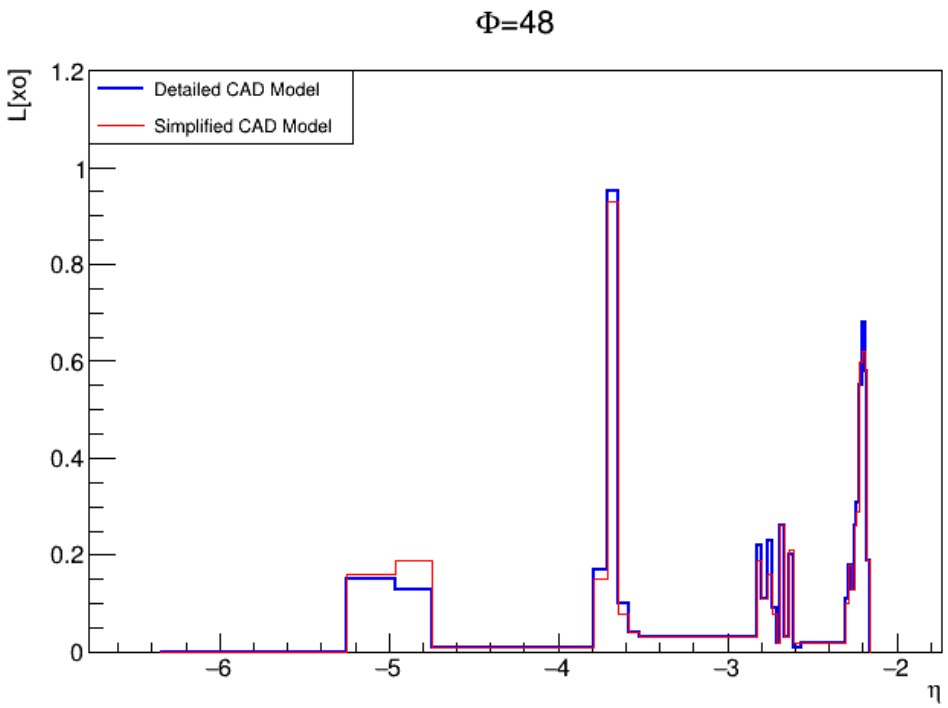


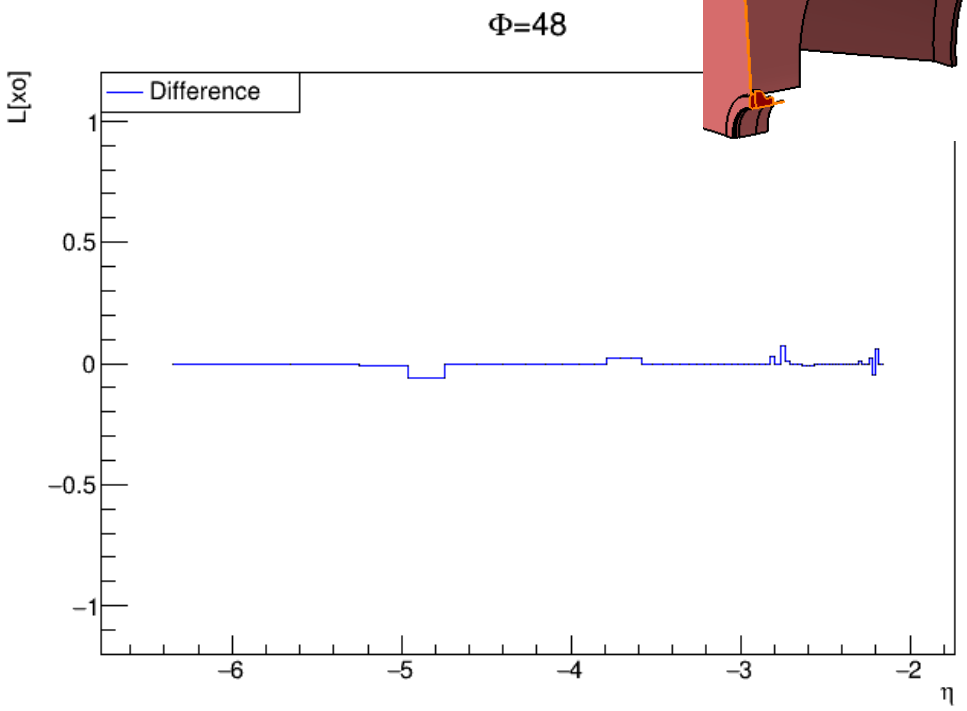


4. Calculation of the Radiation Length (Xo) - Φ = 48







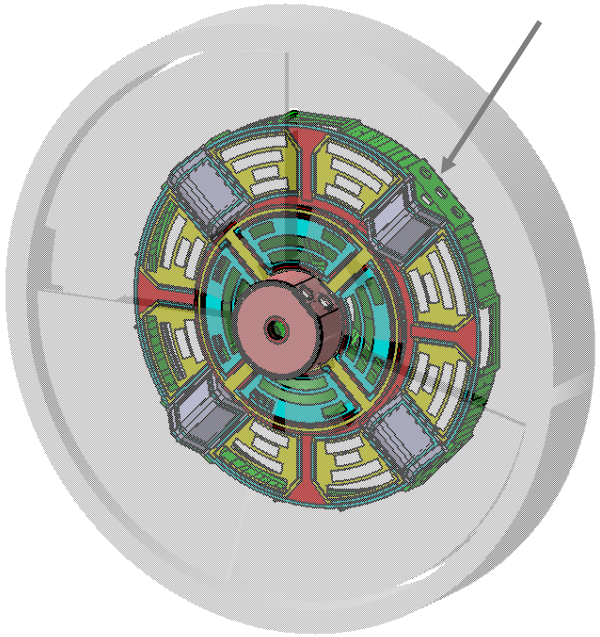


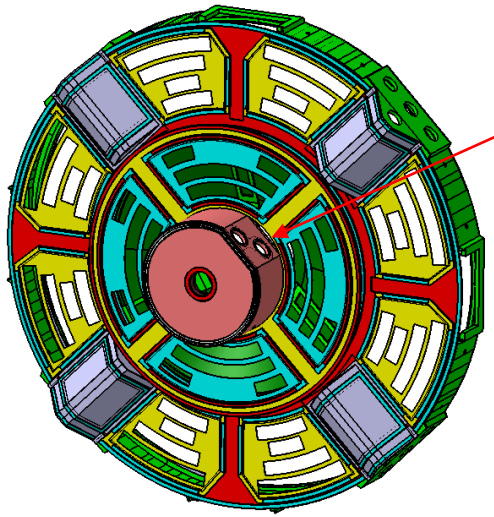
5. Integration Conflicts Checking

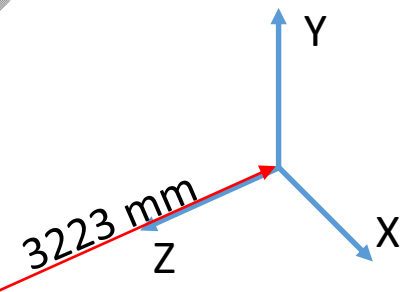
5. Integration Conflicts Checking

Front View

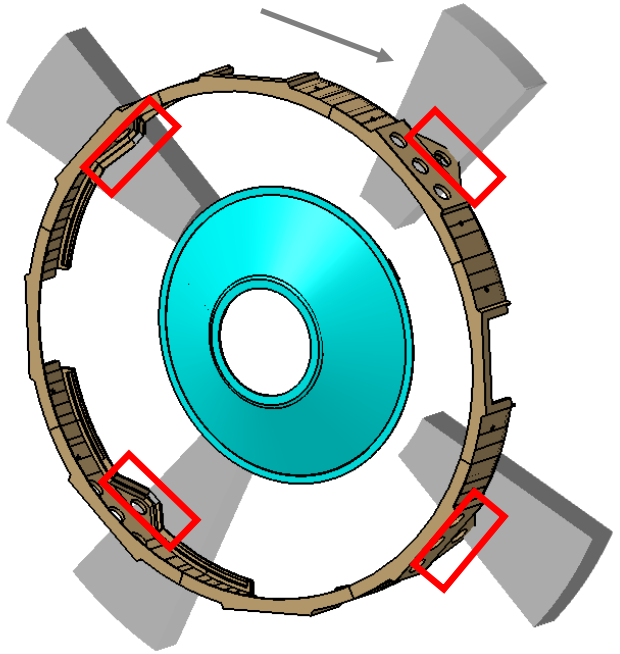
New CAD Model





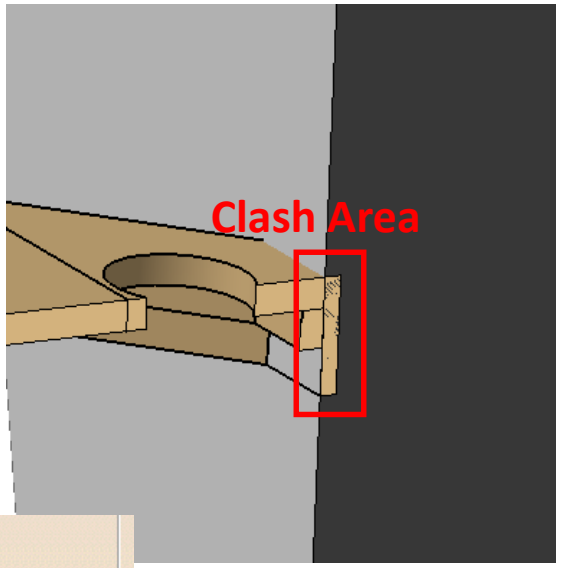


CoolingOuterWheel



Example of the detected conflict

Cut View



Filter list: Clash | No filter on value | All statuses

List by Conflict | List by Product | Matrix

No.	Product 1	Product 2	Type	Value	Statu
1	CoolingOuterWheel (CoolingOuterWheel.1)	Part3 (Part3.1)	Clash	-5.82	Relev
3	CoolingOuterWheel (CoolingOuterWheel.1)	Part3 (Part3.1)	Clash	-5.82	Relev
5	CoolingOuterWheel (CoolingOuterWheel.1)	Part3 (Part3.1)	Clash	-5.82	Relev
7	pixSvc_PP1_T2_R420_R1000_CoolingSum (pixSvc_P...	Part3 (Part3.1)	Clash	-5.82	Relev

73 clashes were detected in total

6. Codding, Check for similarity and internal conflicts

6. Preparation of GMX Description

```
 <!-- PP1 Inner wall -->
<tube name="PP1_innerwall_MainTube" rmin="180.01" rmax="419." zhalflength="1." />
<tube name="PP1_innerwall_CutTube" rmin="207." rmax="375." zhalflength="2." />
<box name="PP1_innerwall_CutBox" xhalflength="40."  yhalflength="200." zhalflength="3."/>

 <subtraction name="PP1_innerwall_Sub1">
   <shaperef ref="PP1_innerwall_CutTube"/>
     <transformation name="PP1_innerwall_Sub1_Tr1">
        <translation x="207."/>
        <translation y="207."/>
        <rotation zcos="1." angle="-45*DtoR"/>
      </transformation>
   <shaperef ref="PP1_innerwall_CutBox"/>
 </subtraction>

 <subtraction name="PP1_innerwall_Sub2">
   <shaperef ref="PP1_innerwall_Sub1"/>
     <transformation name="PP1_innerwall_Sub2_Tr1">
        <translation x="207."/>
        <translation y="-207."/>
        <rotation zcos="1." angle="-135*DtoR"/>
      </transformation>
   <shaperef ref="PP1_innerwall_CutBox"/>
 </subtraction>

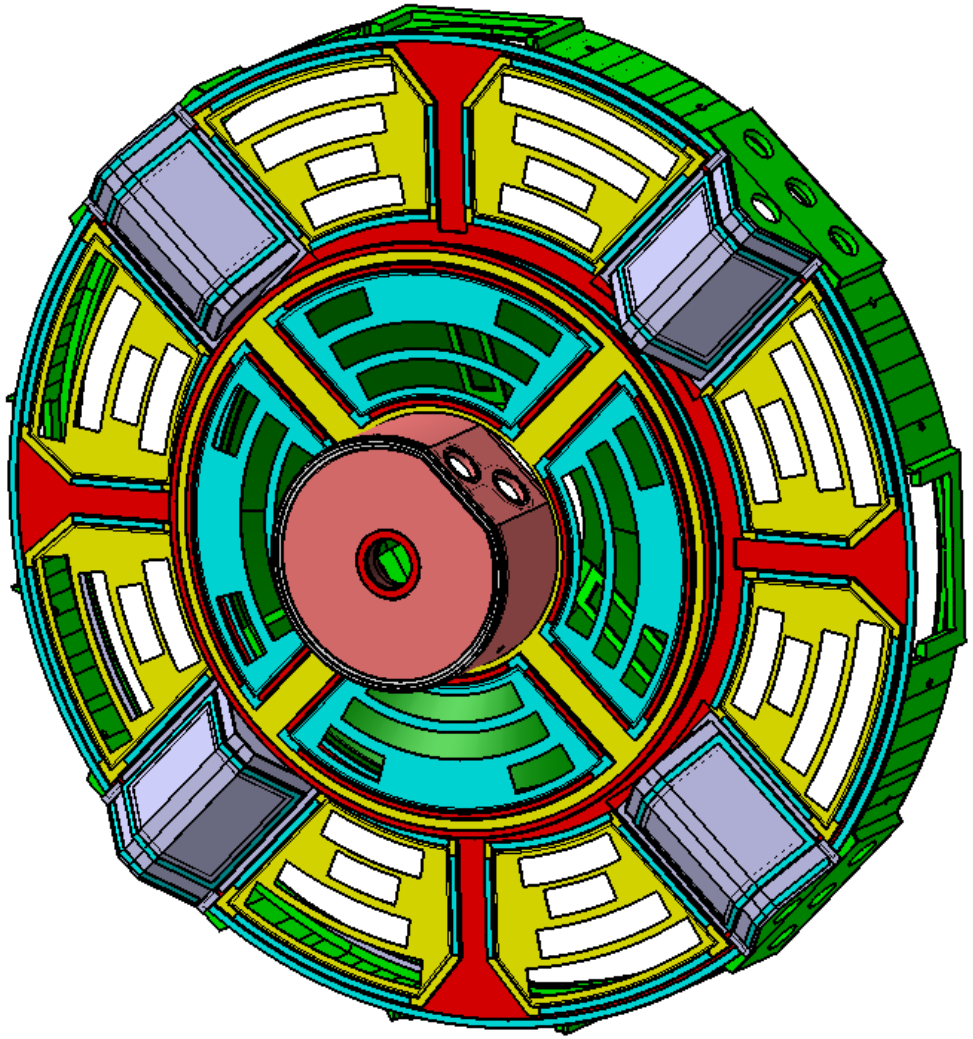
 <subtraction name="PP1_innerwall_Sub3">
   <shaperef ref="PP1_innerwall_Sub2"/>
     <transformation name="PP1_innerwall_Sub3_Tr1">
        <translation x="-207."/>
        <translation y="-207."/>
        <rotation zcos="1." angle="135*DtoR"/>
      </transformation>
   <shaperef ref="PP1_innerwall_CutBox"/>
 </subtraction>

 <subtraction name="PP1_innerwall_Sub4">
   <shaperef ref="PP1_innerwall_Sub3"/>
```

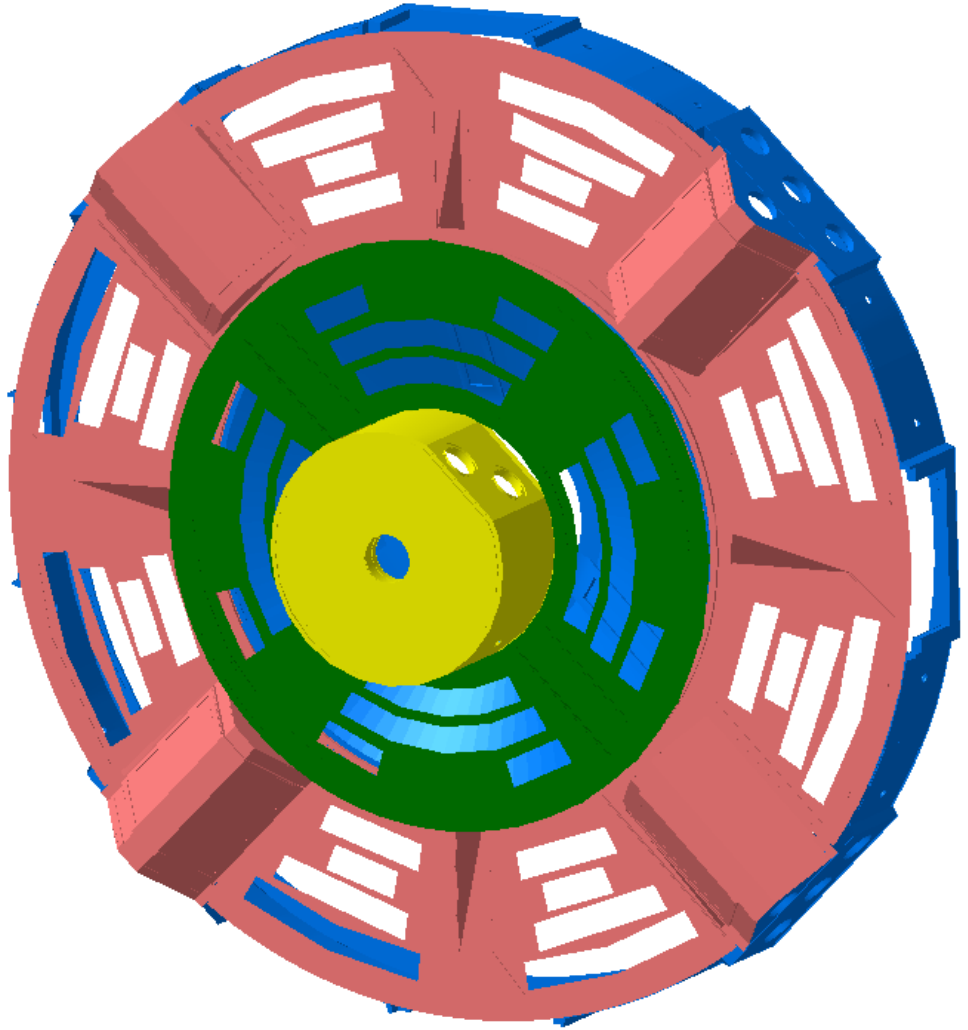
1’456 Programing strings
74 Solids
83 Boolean Operations

6. Check for similarity

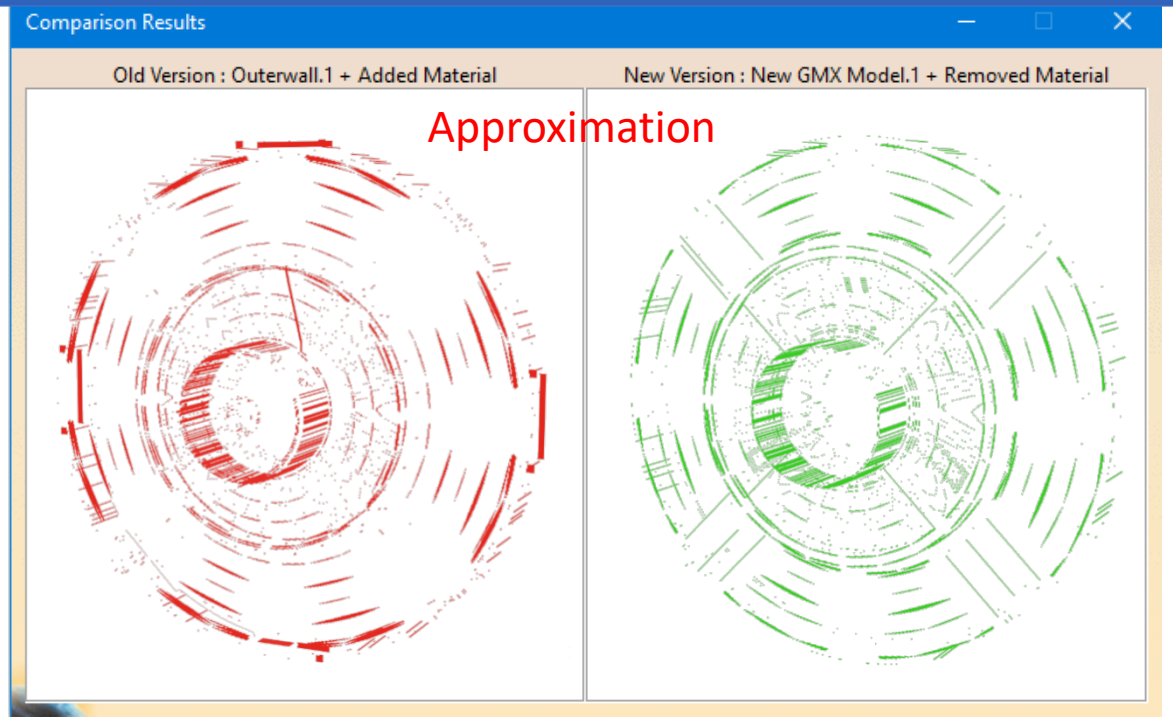
Simplified CATIA Model

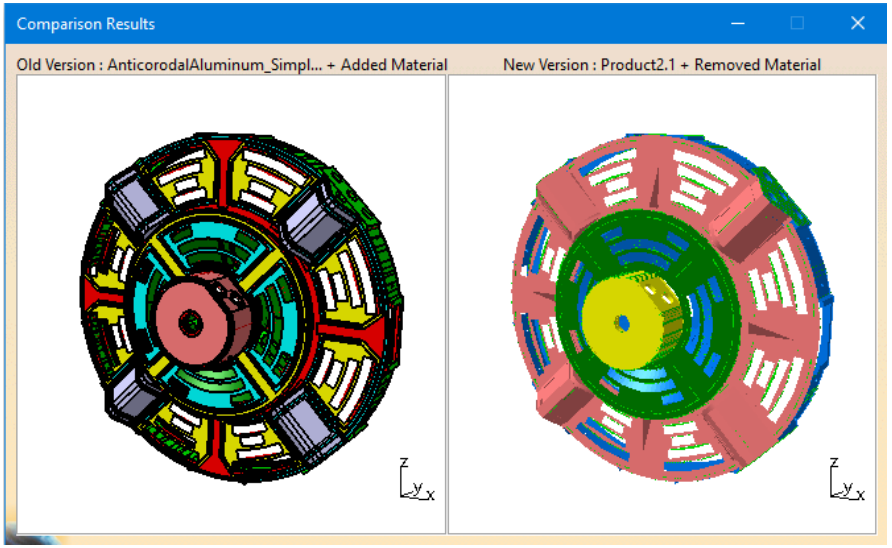


New GMX Description

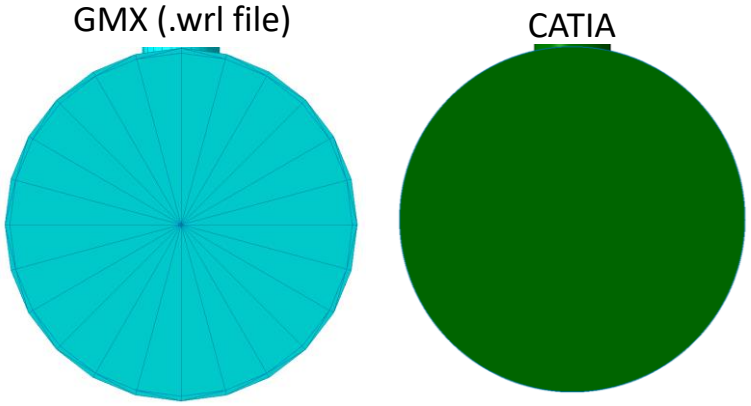


6. Check for similarity





Approximation



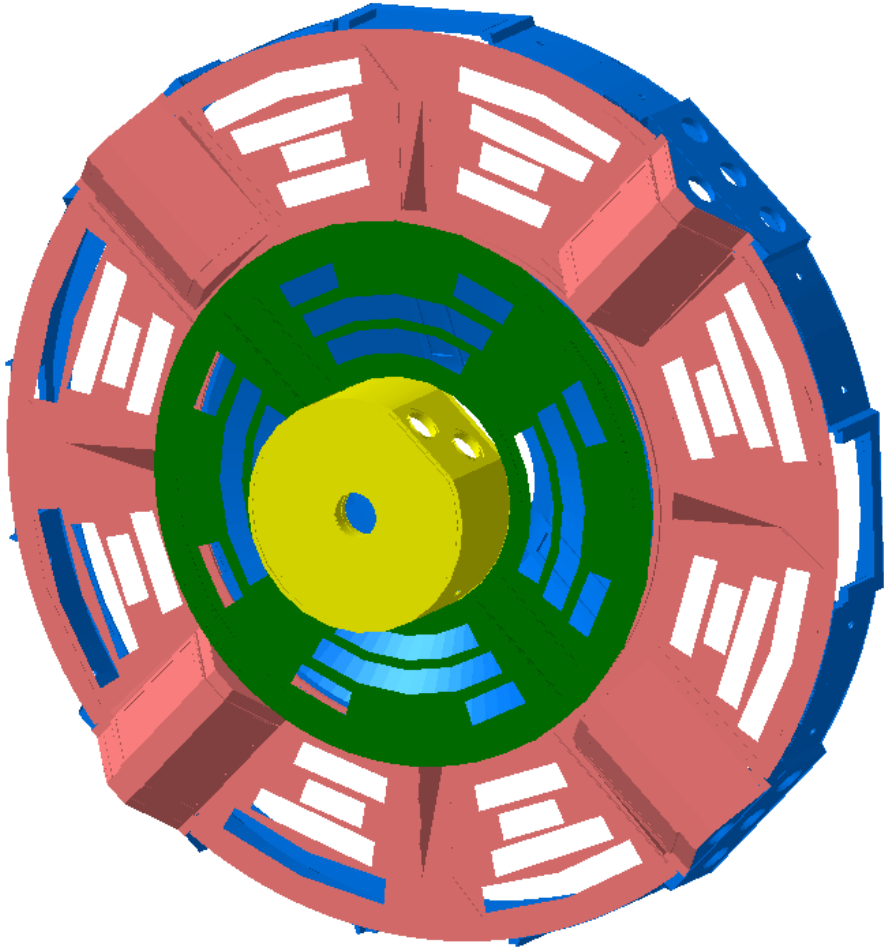
GeoModel -> GDML -> .wrl -> CATIA

Approximation for cylindrical objects (New Description) comes from the Visualization Inaccuracies

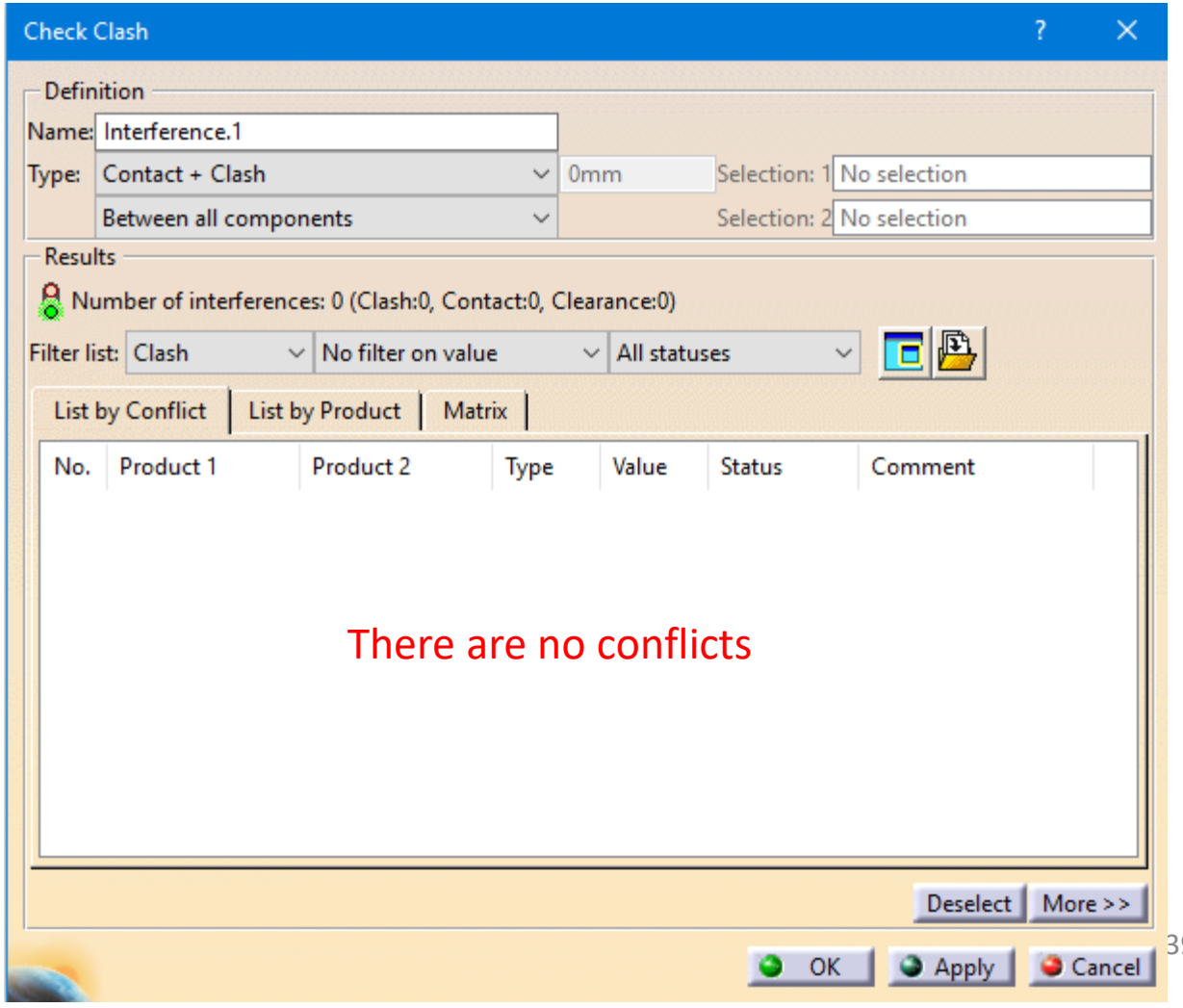
Approximation does not exist is the Simulation. So, there are no differences between CATIA Simplified Model and New GMX Description

6. Internal Conflict Checking – Using CATIA

New GMX Description

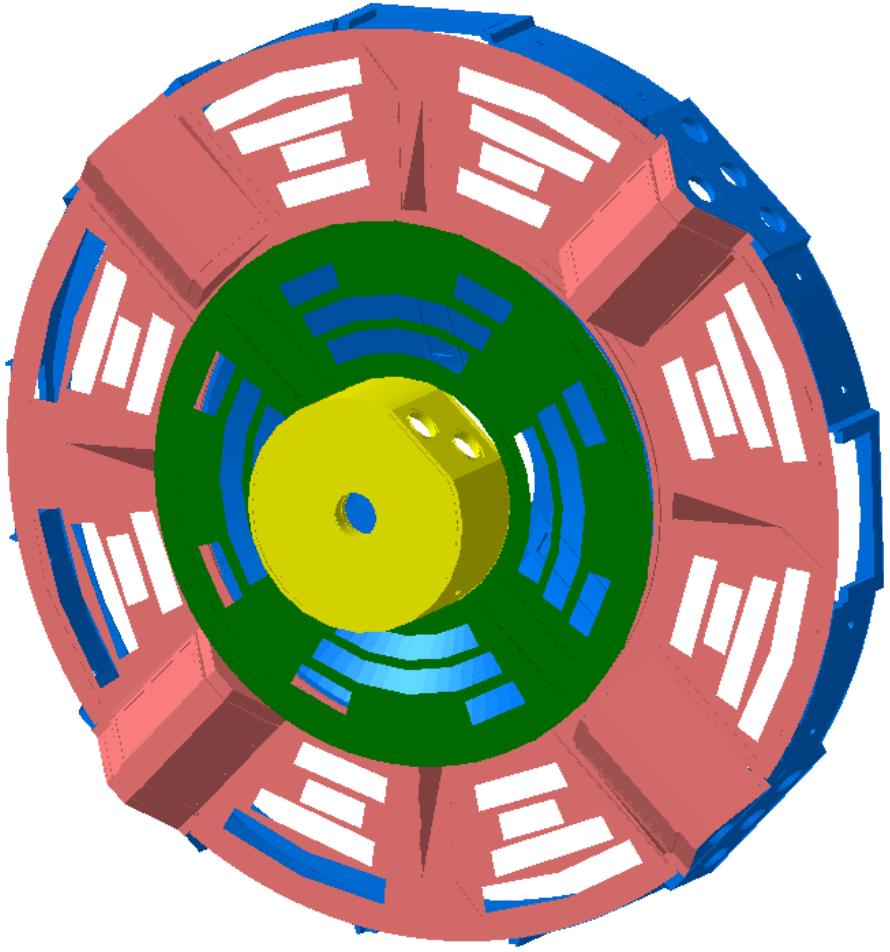


There are no internal conflicts between separate parts of New GMX Description



6. Internal Conflict Checking – Using GMClash

New GMX Description



There are no internal conflicts between separate parts of New GMX Description

```
nika@nika-VirtualBox: ~/Packages/ITKLayouts-modified/ITKLayouts/data/Pixel

Building the detector from the GDML file: geometry.gdml
G4GDML: Reading 'geometry.gdml'...
G4GDML: Reading definitions...
G4GDML: Reading materials...
G4GDML: Reading solids...
G4GDML: Reading structure...
G4GDML: Reading setup...
G4GDML: Reading 'geometry.gdml' done!
Stripping off GDML names of materials, solids and volumes ...
Detector Construction from the GDML file geometry.gdml, done!
**** Real time elapsed   : 0.0590124
**** User time elapsed   : 0.02
**** System time elapsed : 0.01

 ==================  Starting Clashes Detection  ==================


**** Real time elapsed   : 0.145131
**** User time elapsed   : 0.12
**** System time elapsed : 0

**** Writing out the clashes report file: result.json

==================== Recursive overlap check done! ====================
nika@nika-VirtualBox:~/Packages/ITKLayouts-modified/ITKLayouts/data/Pixel$
```

There are no conflicts

Clash_Report.json

```
Open   Clash_Report.json
       ~/packages/GMClash/install/bin   Save

1 {
2     "ClashesReport": [
3 }
4
```

There are no conflicts

Results at GitLab

https://gitlab.cern.ch/ntsutski/itk_projects/-/tree/master/Project%20N5%20-%20Anticorodal%20Aluminum%20Structure%20of%20ITk%20Pixel%20PP1

master | Lock | History | Find file | Web IDE | Clone

itk_projects

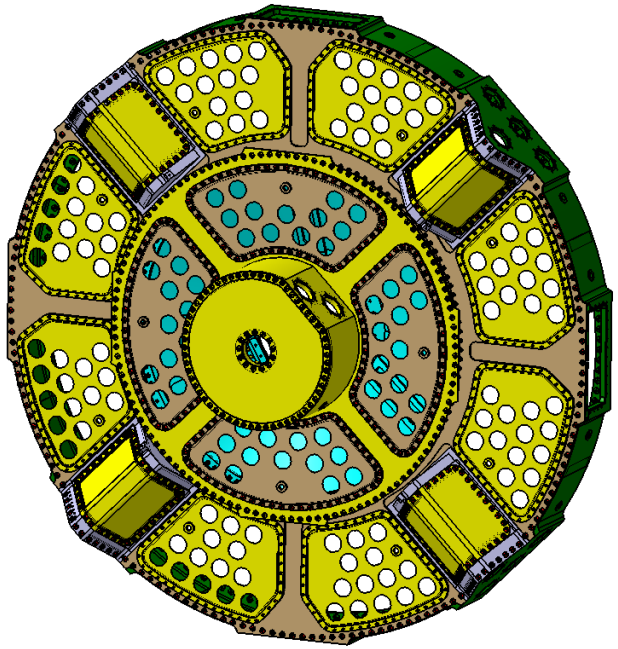
/ Project N5 - Anticorodal Aluminum Structure of ITk Pixel PP1

/ +

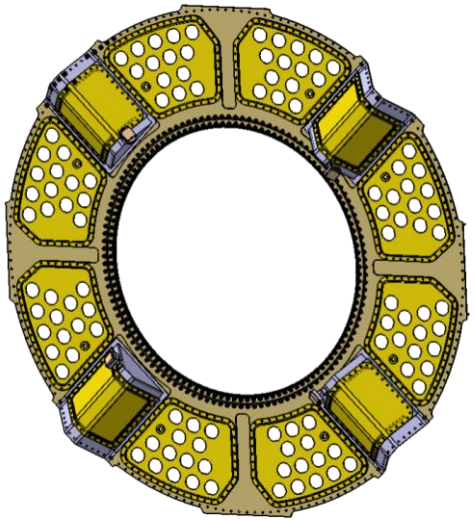
Name	Last commit	Last update
..		
.gitkeep	Anticorodal Aluminum Structure of ITk Pixel PP1	5 minutes ago
1._Compare_Analyses_-_Volume_Weight....	1. Compare Analyses - Volume, Weight, Positioning, ...	3 minutes ago
2._Calculation_of_Radiation_Length_-_d...	Calculation of Radiation Length - Detailed model vs ...	3 minutes ago
3._SImplification.pdf	Simplification	2 minutes ago
4._Calculation_of_Radiation_Length_-_d...	Calculation of Radiation Length - Detailed model vs ...	2 minutes ago
5._Integration_Conflicts_Checking.pdf	Integration Conflicts Checking	1 minute ago
6._Codding__Check_for_similarity_and_i...	Codding, Check for similarity and internal conflicts	1 minute ago
AnticorodalAluminum.gmx	New Description of Anticorodal Aluminium Structure ...	1 minute ago
AnticorodalAluminum.wrl	3D .wrl format file of Anticorodal Aluminium Structure	just now

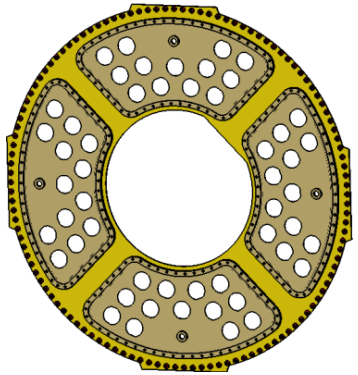
Backup slide – Other 4 projects at GitLab

Assembly



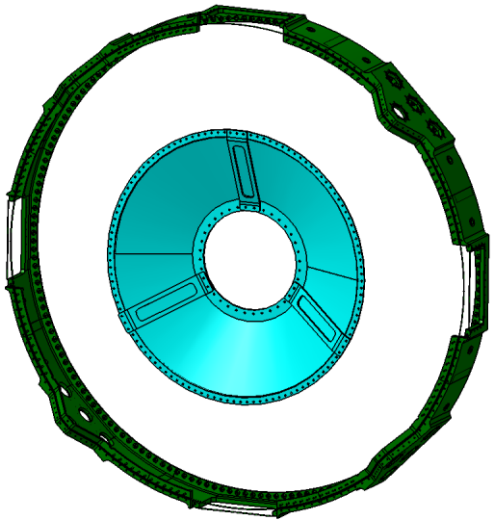
Project N1:
Outer Patch Panel
Cooling Housing
Outer Wall
Bolts

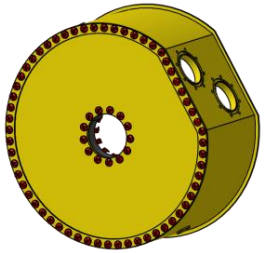




Project N2:
PP1_Inner Wall
Inner Patch Panel
Bolts

Project N4:
PP1 outer flange
Conical flange
Bolts





Project N3:
PP1_Inner Wall Closing Flange
PP1 Inner Cylinder
IPT Interface Flange
Bolts

Project N1 - https://gitlab.cern.ch/ntsutski/itk_projects/-/tree/master/Project%20N1%20-%20PP1_OuterWall
Project N2 - https://gitlab.cern.ch/ntsutski/itk_projects/-/tree/master/Project%20N2%20-%20PP1_Inner%20Wall%20/%20Inner%20Patch%20Panel
Project N3 - https://gitlab.cern.ch/ntsutski/itk_projects/-/tree/master/Project%20N3%20-%20PP1%20Inner%20Cylinder
Project N4 - https://gitlab.cern.ch/ntsutski/itk_projects/-/tree/master/Project%20N4%20-%20PP1%20outer%20flange%20-%20conical%20flange

Thank you for your attention!

მადლობთ ყურადღებისთვის!

Niko Tsutskiridze
niko.Tsutskiridze@cern.ch