Investigation of Cooling Systems in PP1

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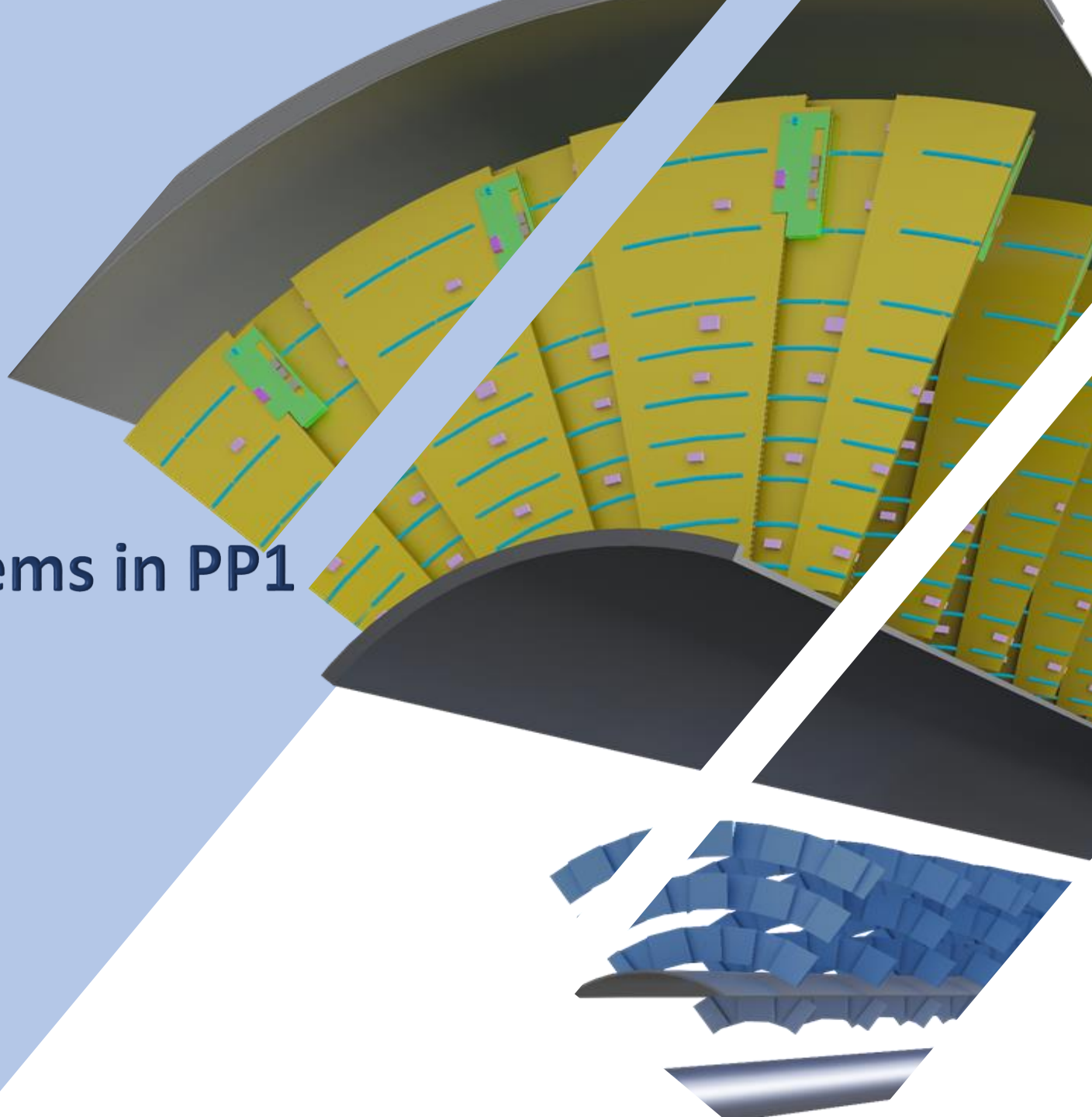
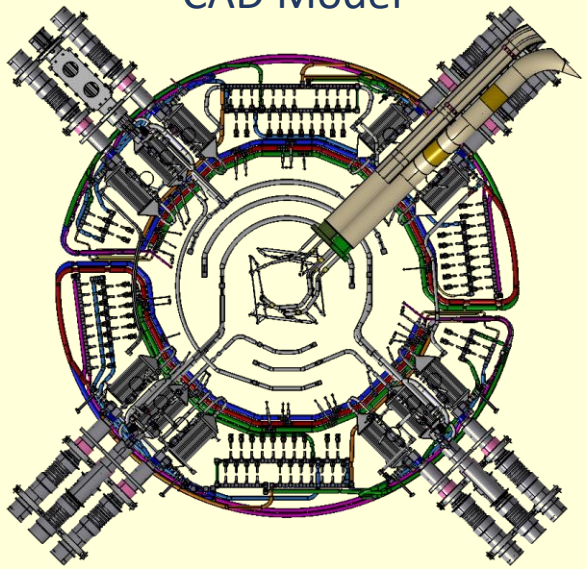
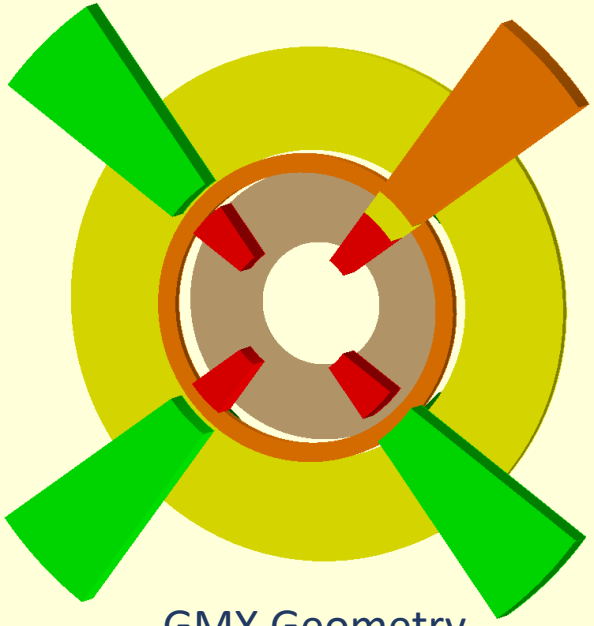


Working Life Cycle

CAD Model

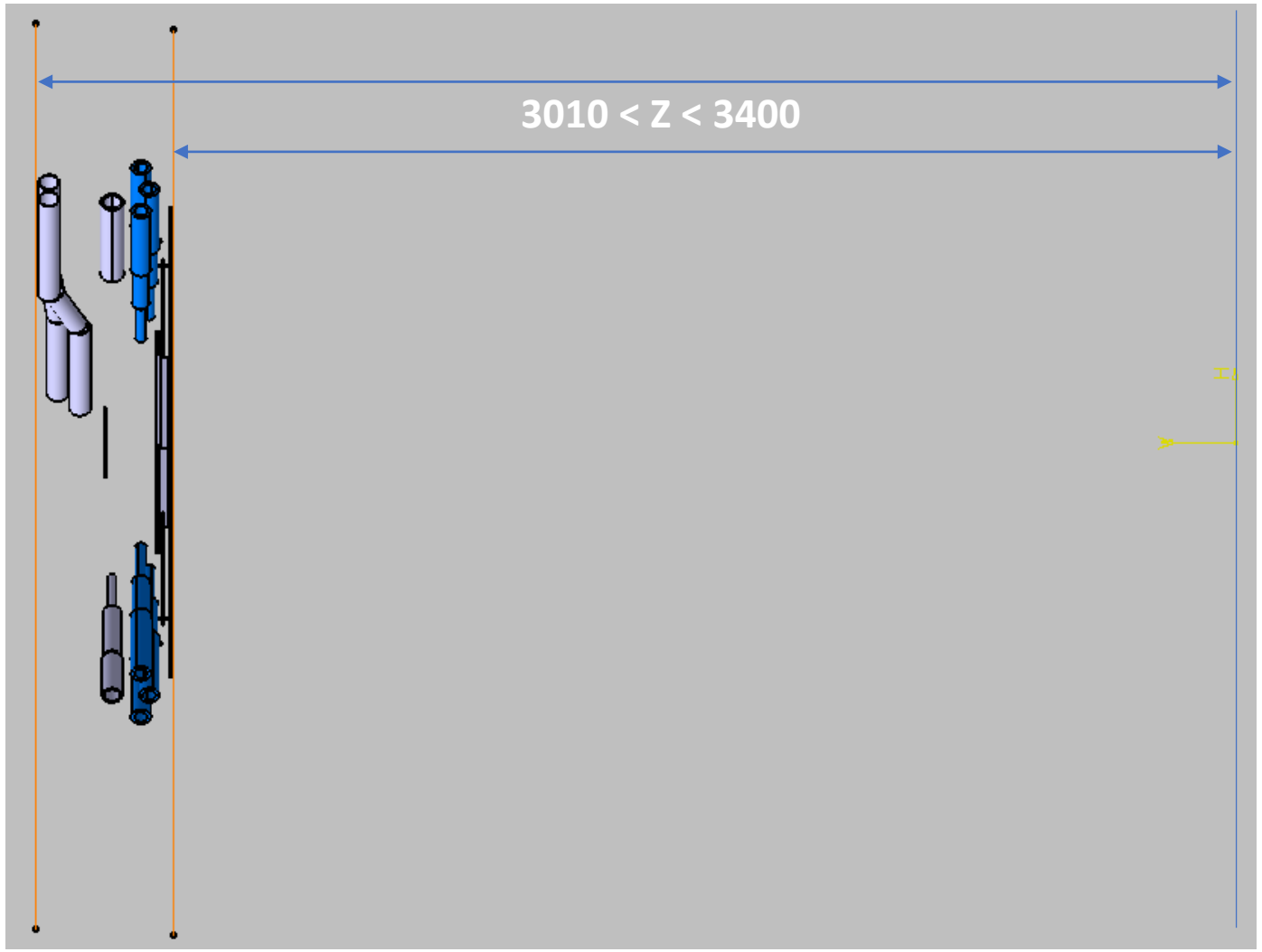


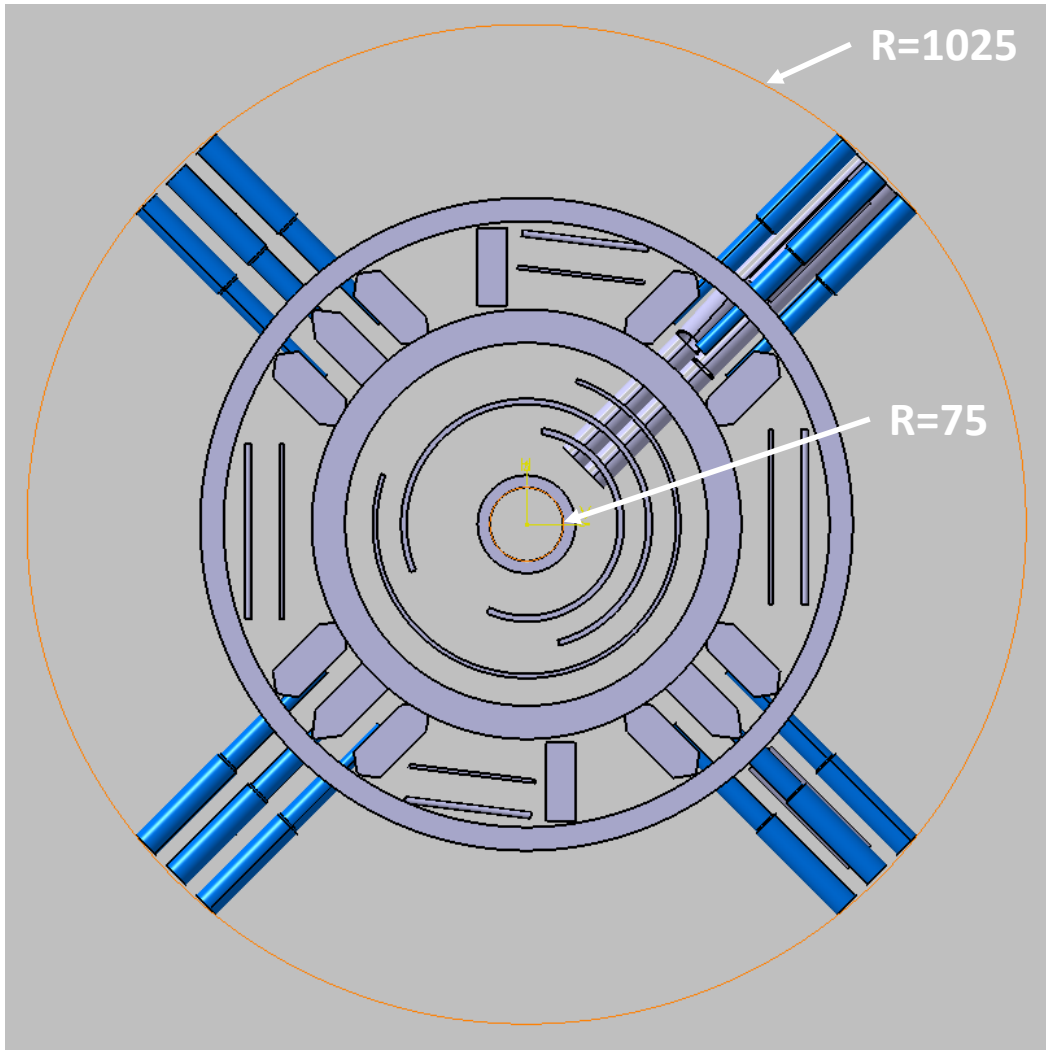


GMX Geometry

1. Compare Analyses (Weight) – Detailed CAD Model vs. GMX Geometry
2. Calculation of the Radiation Length (Xo) – Detailed CAD Model vs. GMX Geometry
3. Simplification of the Detailed CAD Model
4. Preparation of GMX Description
5. Integration Conflicts Checking

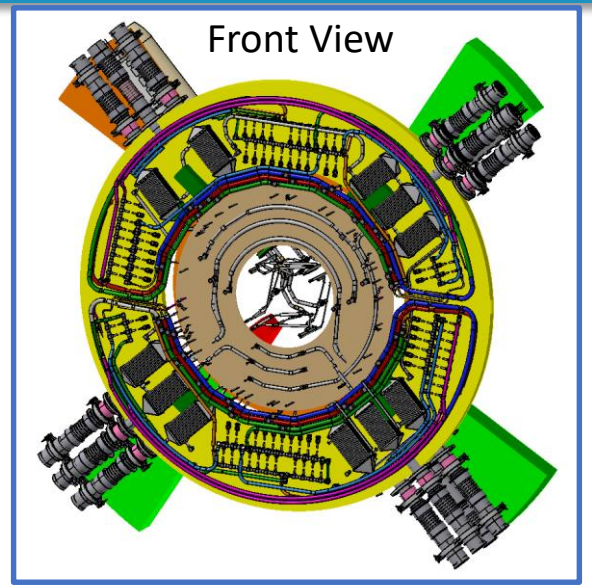
Location of Cooling Systems in PP1

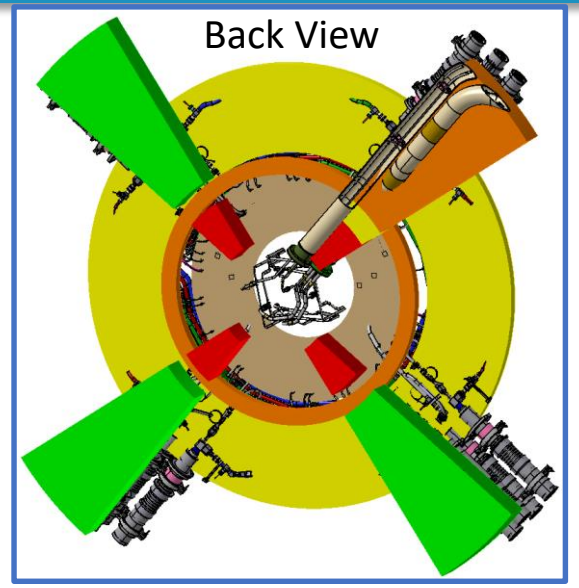


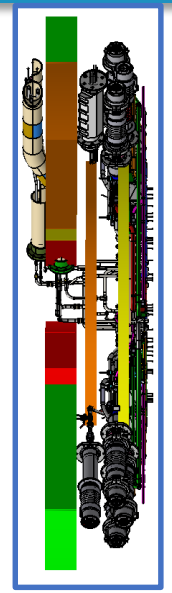


1. Compare Analyses (Weight)
Detailed CAD Model vs. GMX Geometry

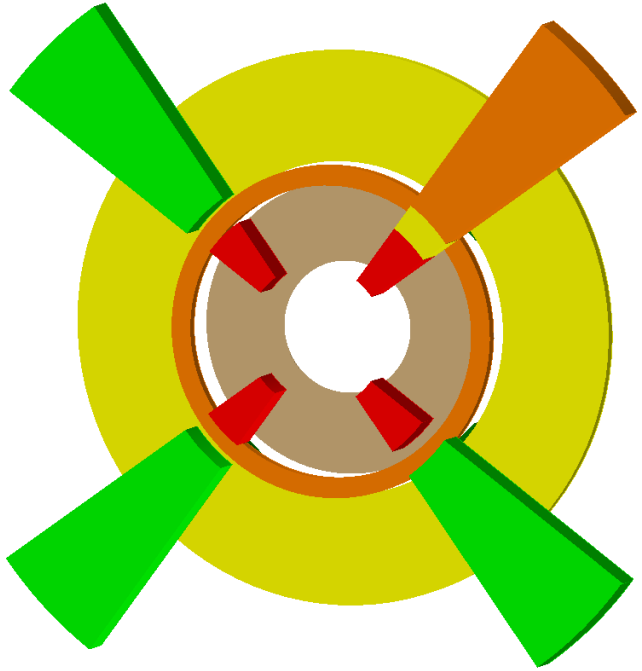
GMX Description Vs. Detailed CAD Model



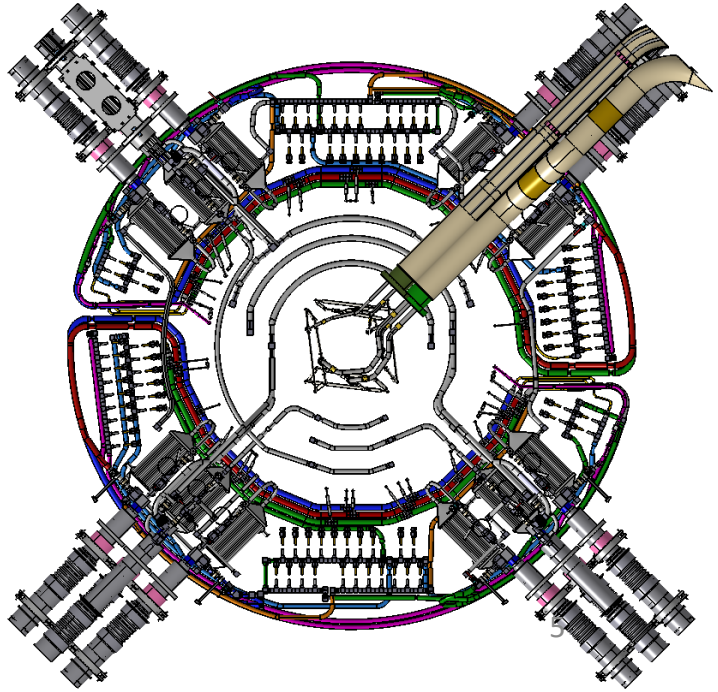




GMX Description

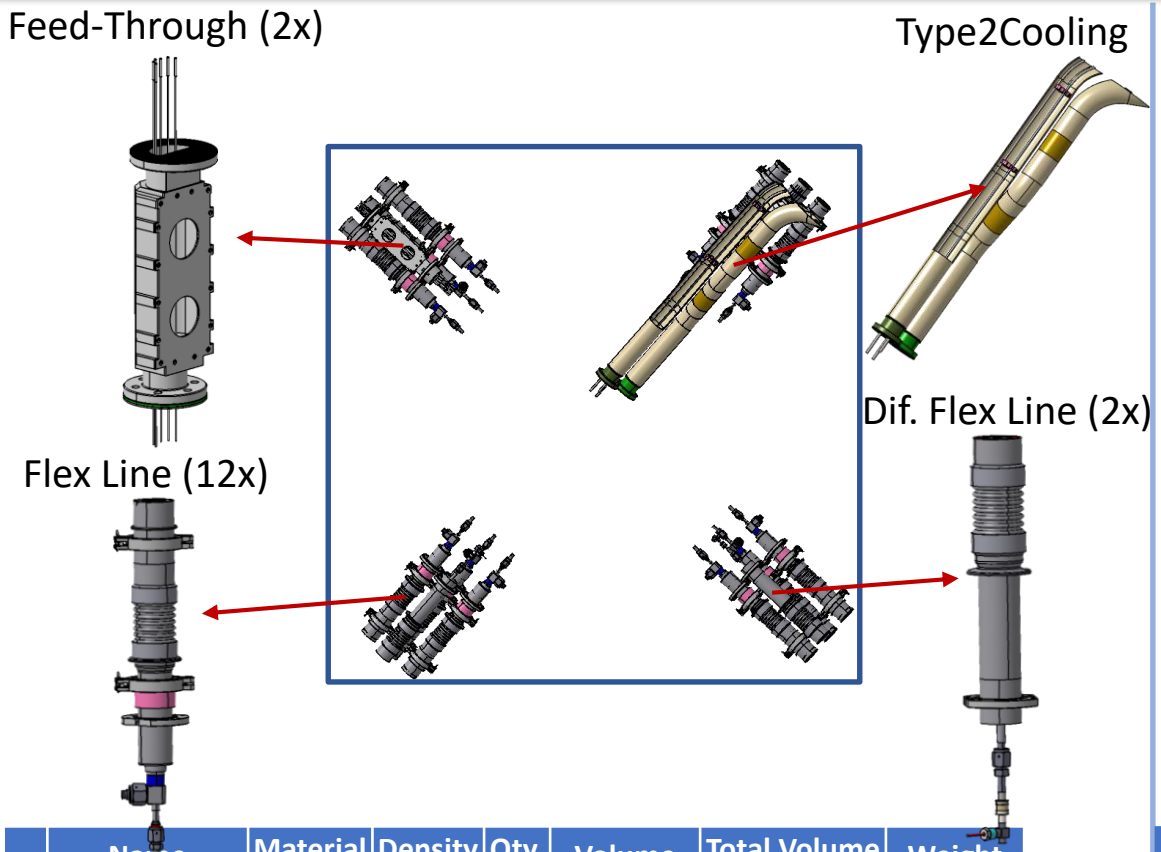


Detailed CAD Model

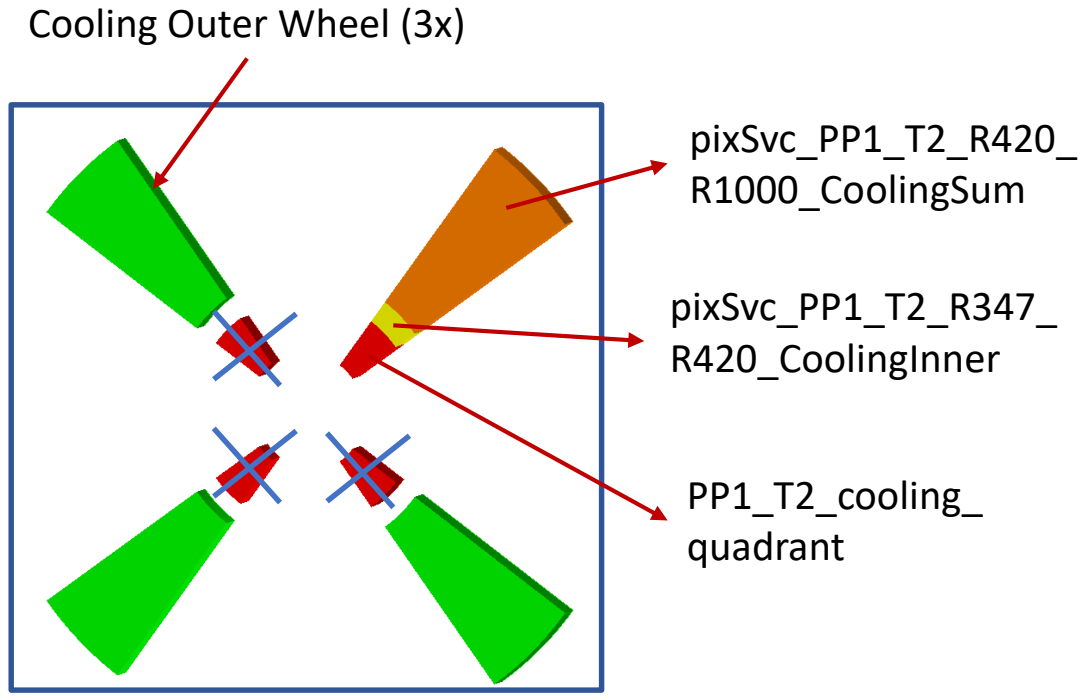


Thanks to **Emiliano Dane** for Detailed CAD model and Materials

Assembly 1 - Parts of Detailed CAD Model and GMX Simulation

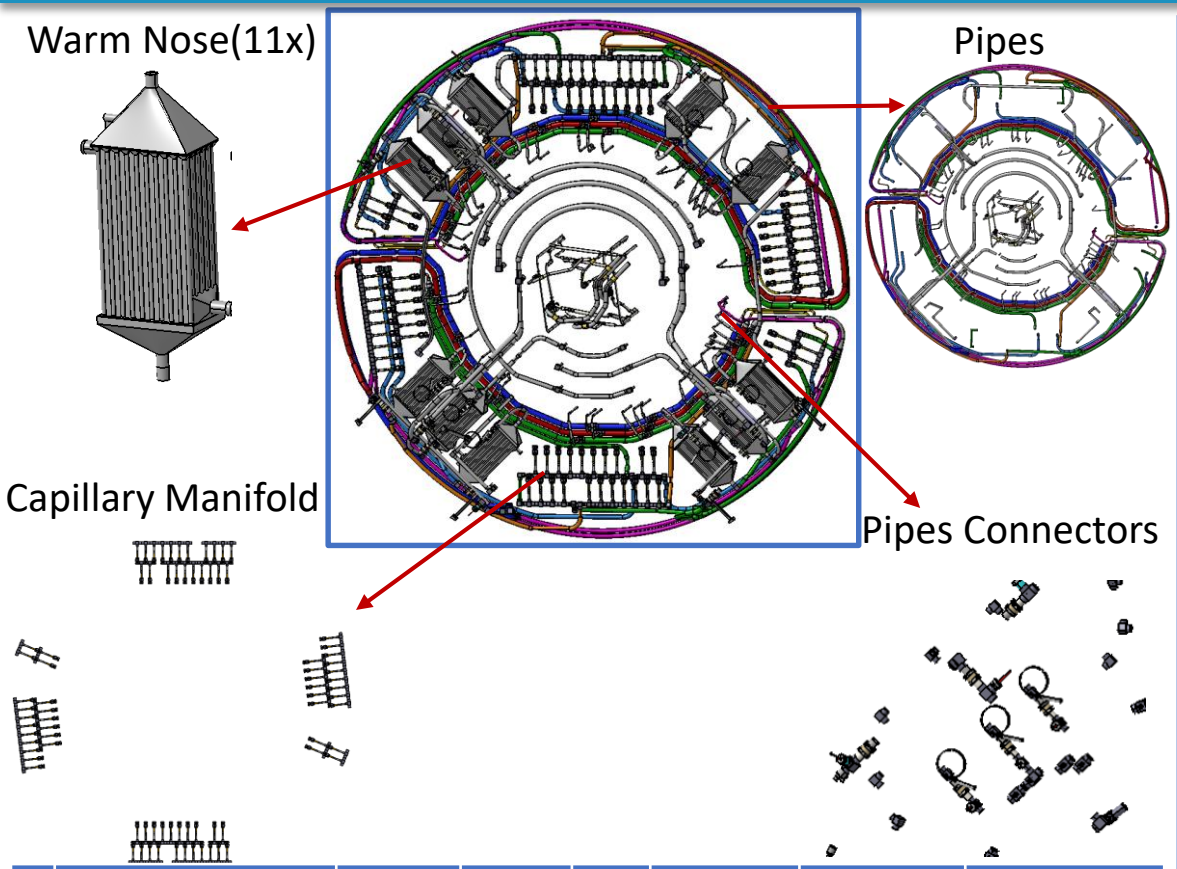


	Name	Material	Density kg/m3	Qty.	Volume (m3)	Total Volume (m3)	Weight (kg)
1	Flex Line	Ssteel	8000	12	0.000549	0.006596	52.7
2	Dif. Flex Line	Ssteel	8000	2	0.000328	0.000656	5.2
3	Type2 Cooling	Ssteel	8000	1	0.001254	0.001254	10
7	Feed-Through	Ssteel	8000	2	0.0004325	0.000865	6.9
						Total:	**74.8**

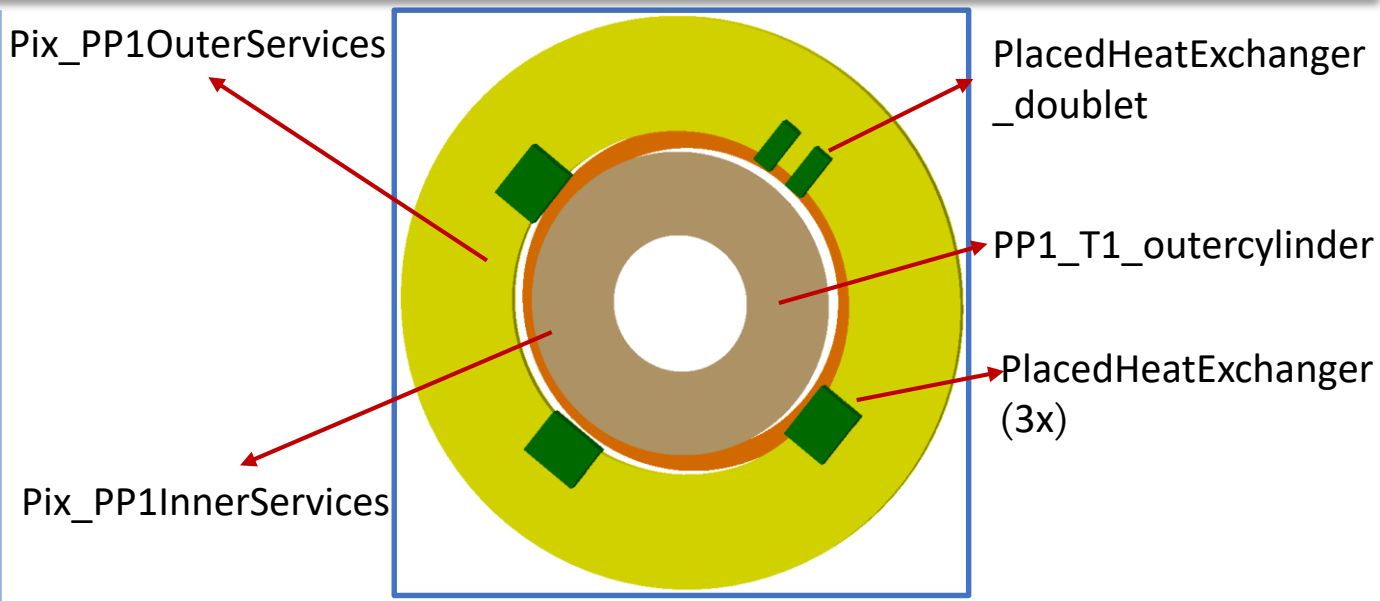


	Name	Material	Density kg/m3	Qty.	Volume (m3)	Total Volume (m3)	Weight (kg)
1	CoolingOuterWheel	matPicCoolingOuter	541.94	3	0.01268	0.038035	20.61
2	pixSvc_PP1_T2_R420_R1000_CoolingSum	matPicCoolingSum	914.06	1	0.012678	0.012678	11.6
3	pixSvc_PP1_T2_R347_R420_CoolingInner	matPicCoolingInner	688.92	1	0.000862	0.000862	0.6
4	PP1_T2_cooling_quadrant	PP1_T1_cooling_Steel	210	1	0.00135	0.00135	0.28
						Total:	**33.09**

Assembly 2 - Parts of Detailed CAD Model and GMX Simulation

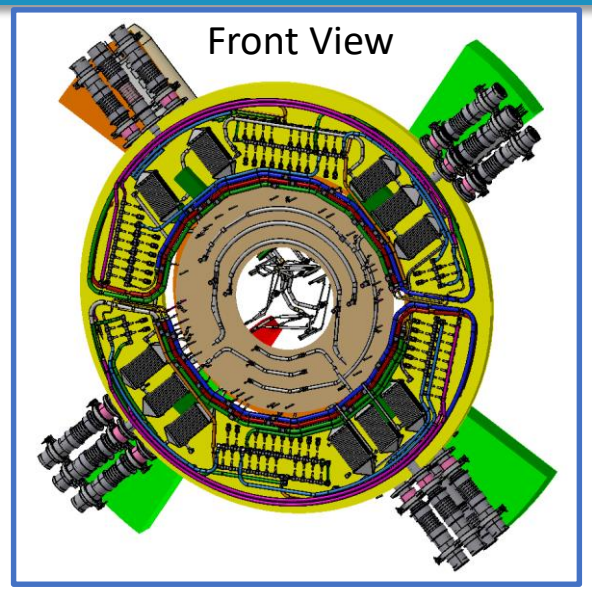


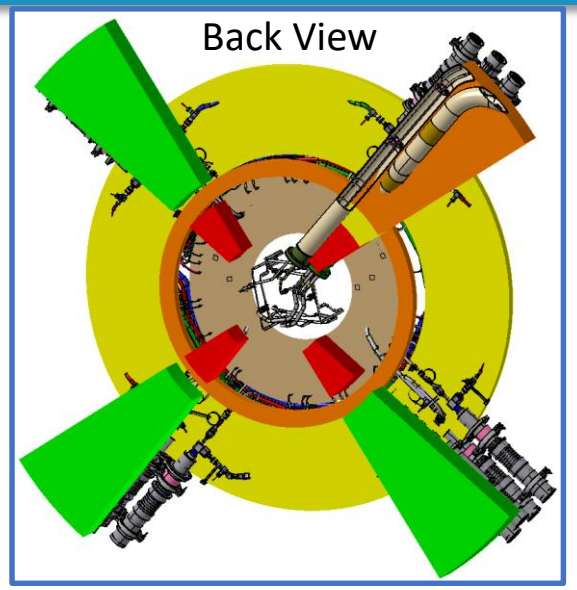
	Name	Material	Density kg/m3	Qty.	Volume (m3)	Total Volume (m3)	Weight (kg)
4	Pipes	Titanium	4500	1	0.001769	0.001769	7.96
5	Capillary Manifold	Titanium	4500	1	0.000327	0.000327	1.4715
6	Pipes Connectors	Titanium	4500	1	0.00049	0.00049	2.205
8	Warm Nose	Titanium	4500	11	6.74545E-05	0.000742	3.339
						Total:	**15**

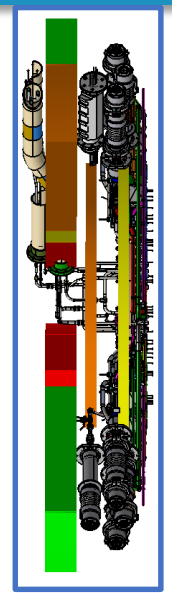


	Name	Material	Density kg/m3	Qty	Volume (m3)	Total Volume (m3)	Weight (kg)
1	Pix_PP1OuterServices	matPP1Type1PixOuter	216.28	1	0.032854	0.032854	7.1
2	Pix_PP1OuterServices	matPP1Type1PixInner	60.2	1	0.00427	0.00427	0.26
3	PP1_T1_outercylinder	PP1_T1-Outer_Cyl	599	1	0.002051	0.002051	1.23
7	PlacedHeatExchanger_doublet	matHeatExchanger	2668.14	1	0.000504	0.000504	1.34
	PlacedHeatExchanger	matHeatExchanger	2668.14	3	0.000756	0.002268	6.05
						Total:	**15.98**

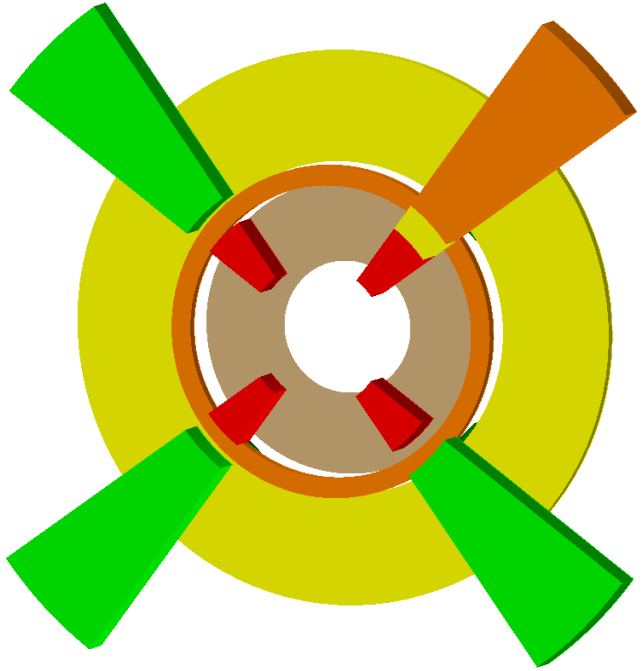
Compare Analyses - GMX Description Vs. Detailed CAD Model





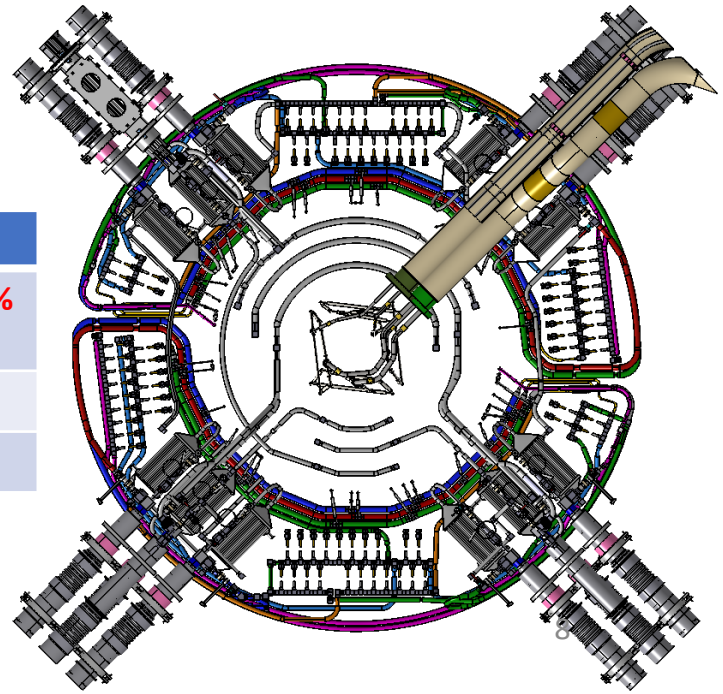


GMX Description



	GMX Description		Detailed CAD Model		
Name	Volume (m3)	Weight (kg)	Total Volume (m3)	Weight (kg)	Diff. (kg) %
Assembly 1	0.0529	33.09	0.009371	74.8	55.7
Assembly 2	0.0419	15.98	0.003328	15	6

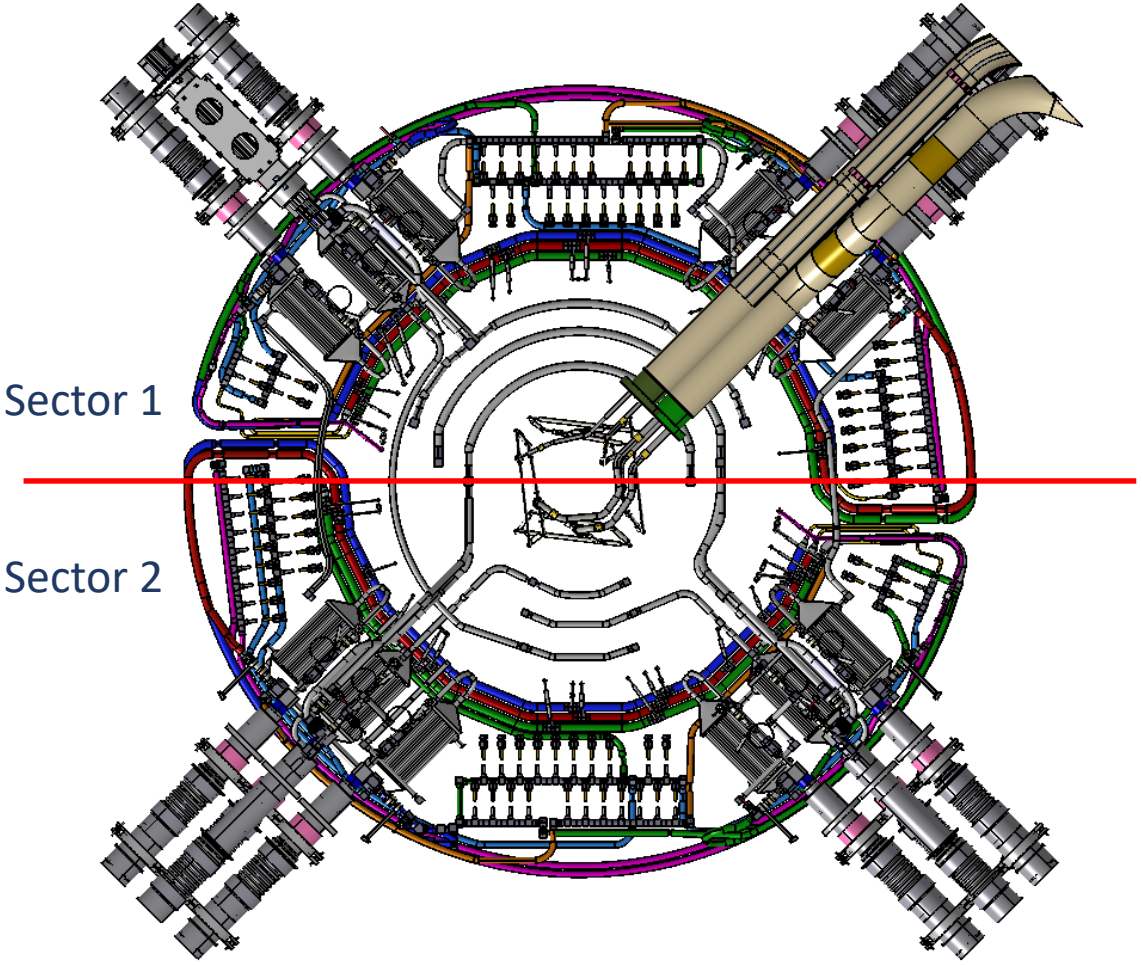
Detailed CAD Model



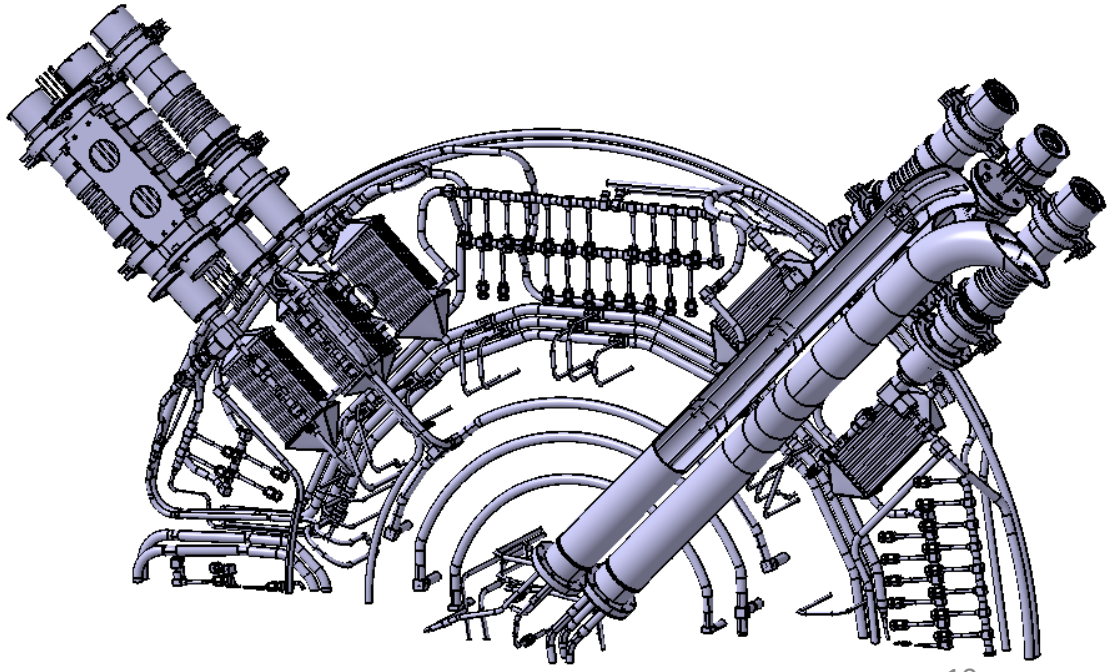
2. Calculation of the Radiation Length (Xo)
Detailed CAD Model vs. GMX Geometry

Compare Analyses – Radiation Length

Detailed CAD Model

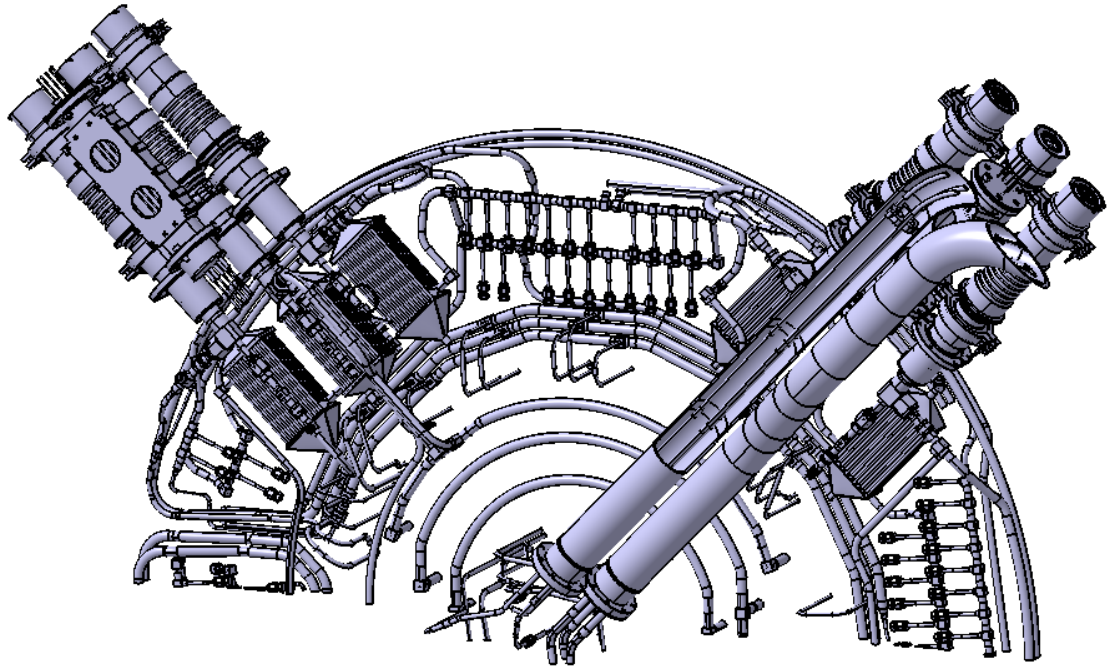


Calculation of the Radiation Length performed for the Sector 1



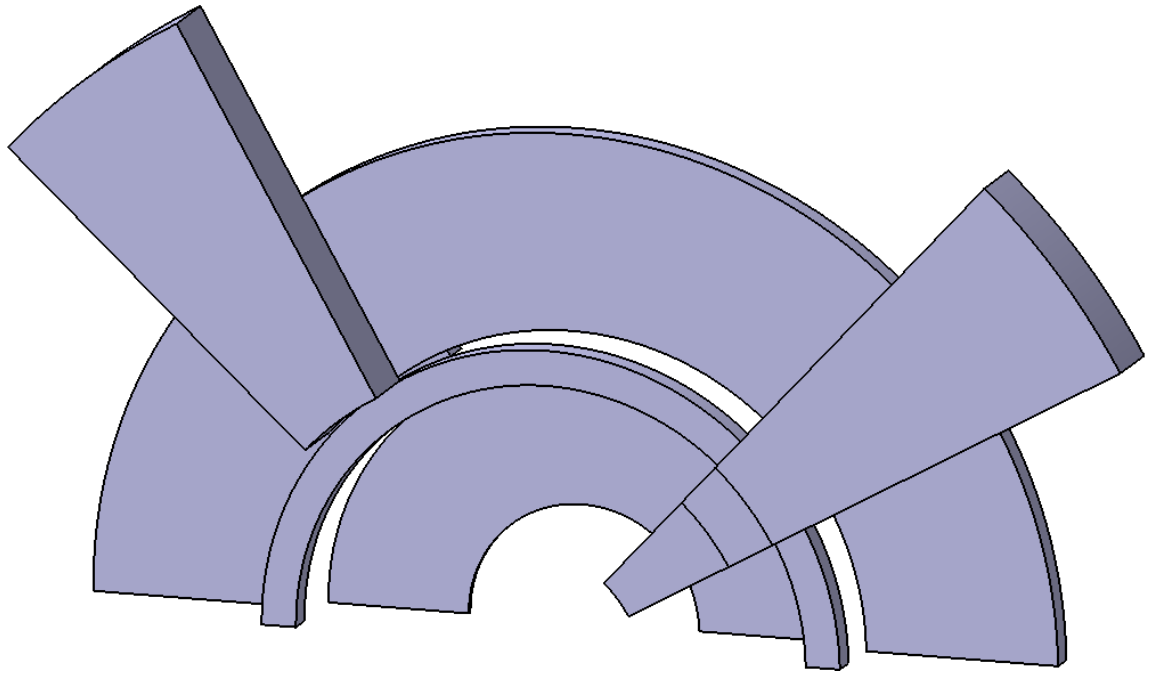
Compare Analyses – Radiation Length

Detailed CAD Model

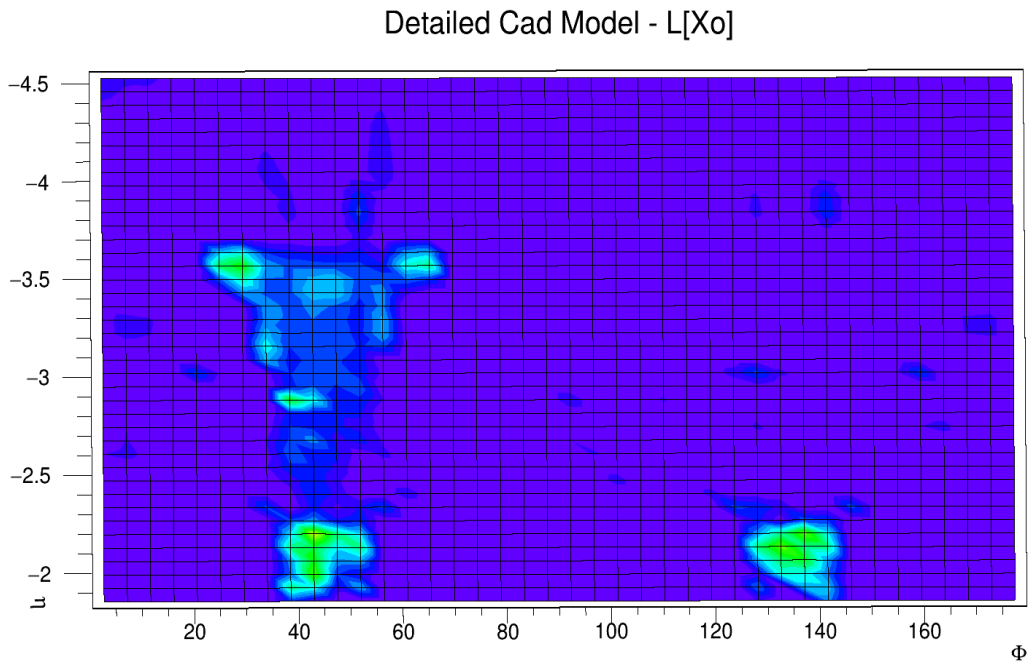


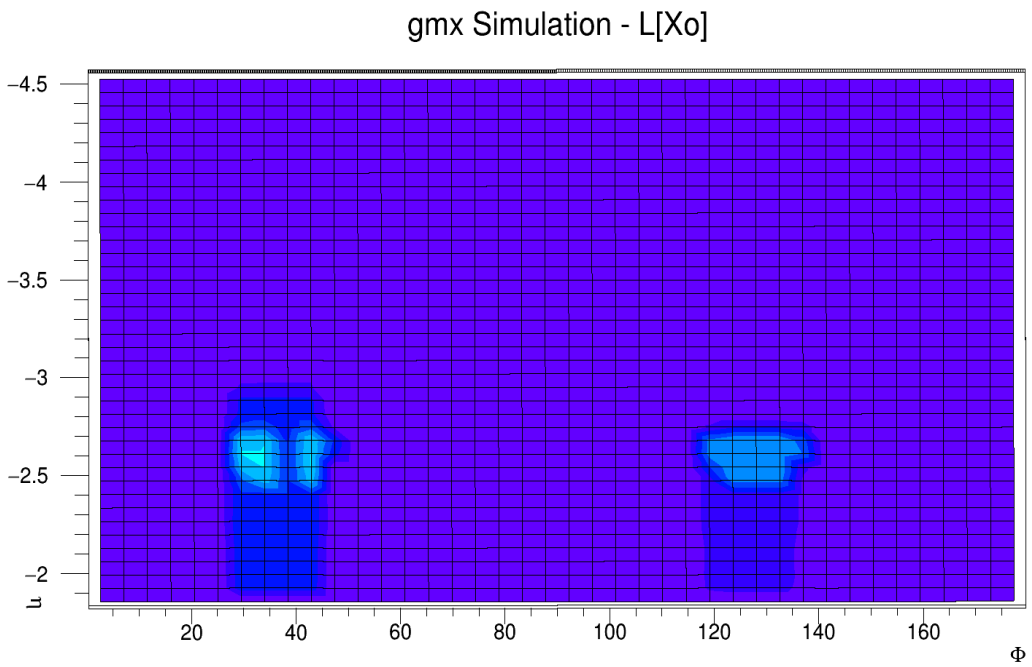
Vs.

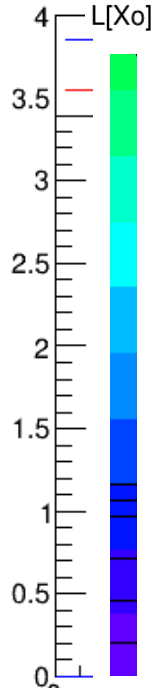
GMX Simulation



Compare Analyses – Radiation Length

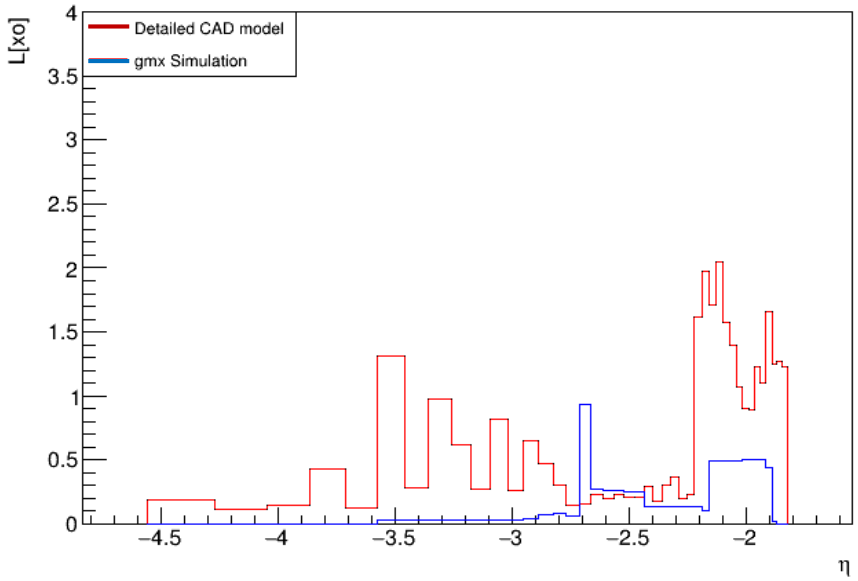




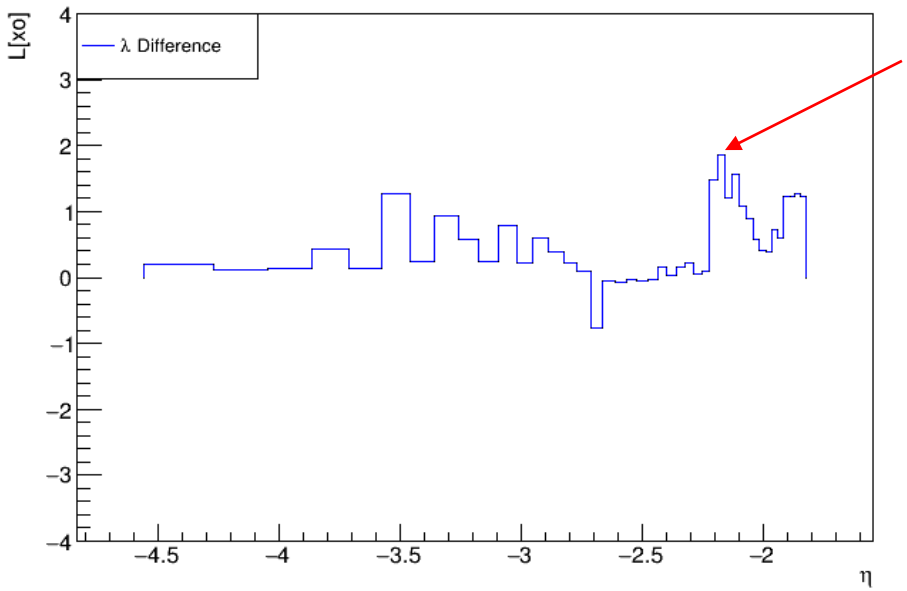


Compare Analyses – Radiation Length (Average Values)

Average (38 < Φ < 135.2)

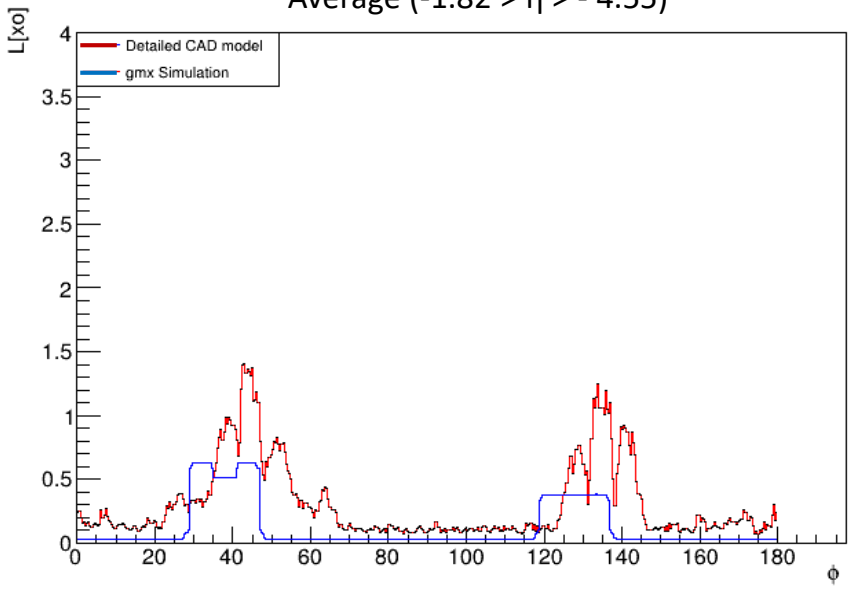


Average (38 < Φ < 135.2)

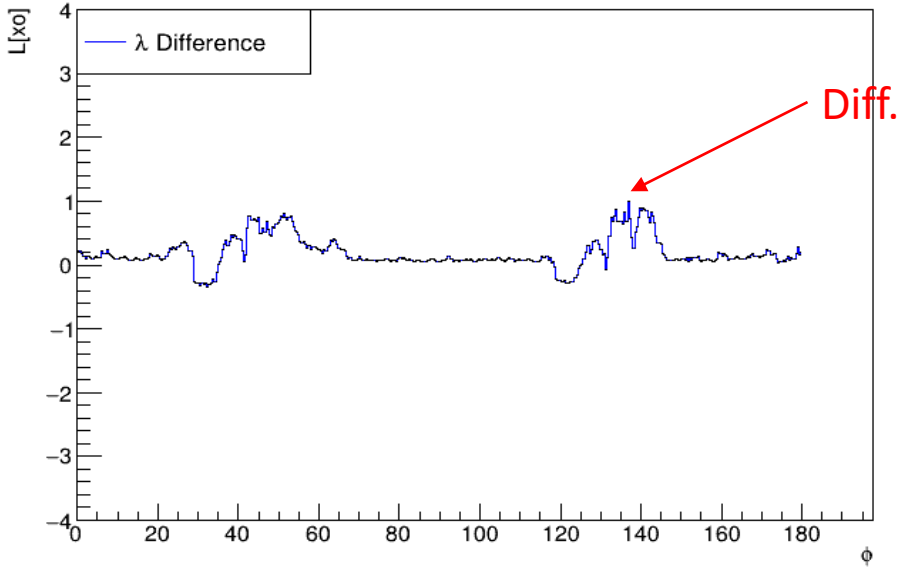


Diff. 76%

Average (-1.82 > η > - 4.55)



Average (-1.82 < η > - 4.55)



Diff. 72%

Calculation of Radiation Length (Xo)

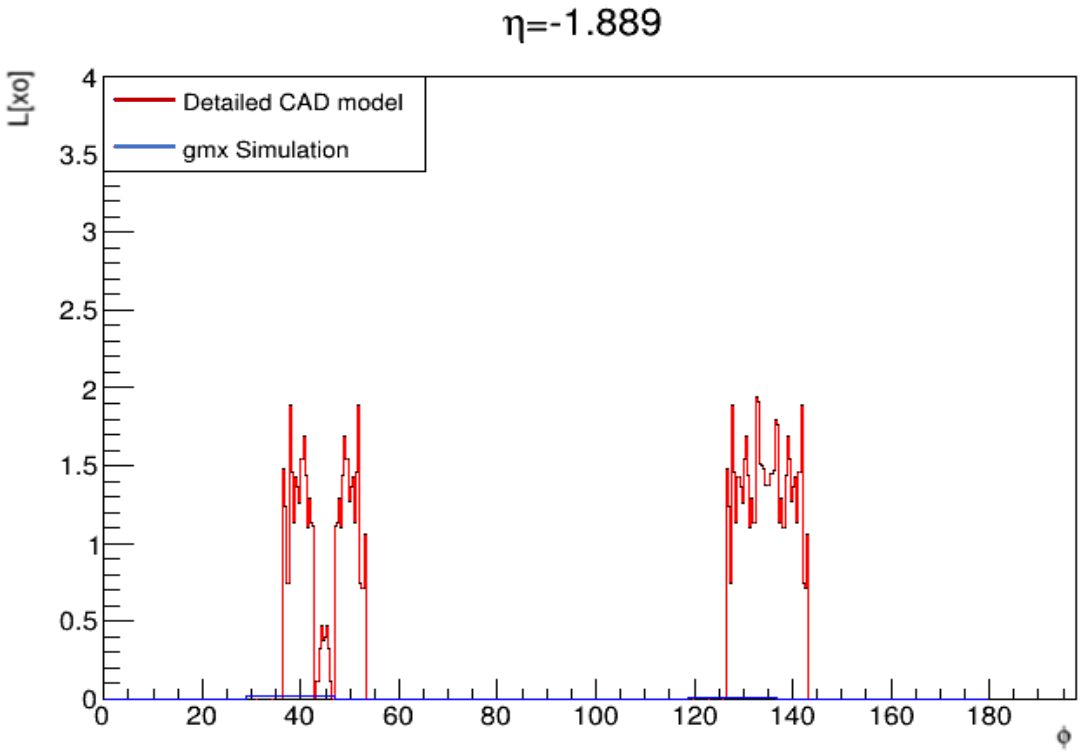
$\eta = -1.889$

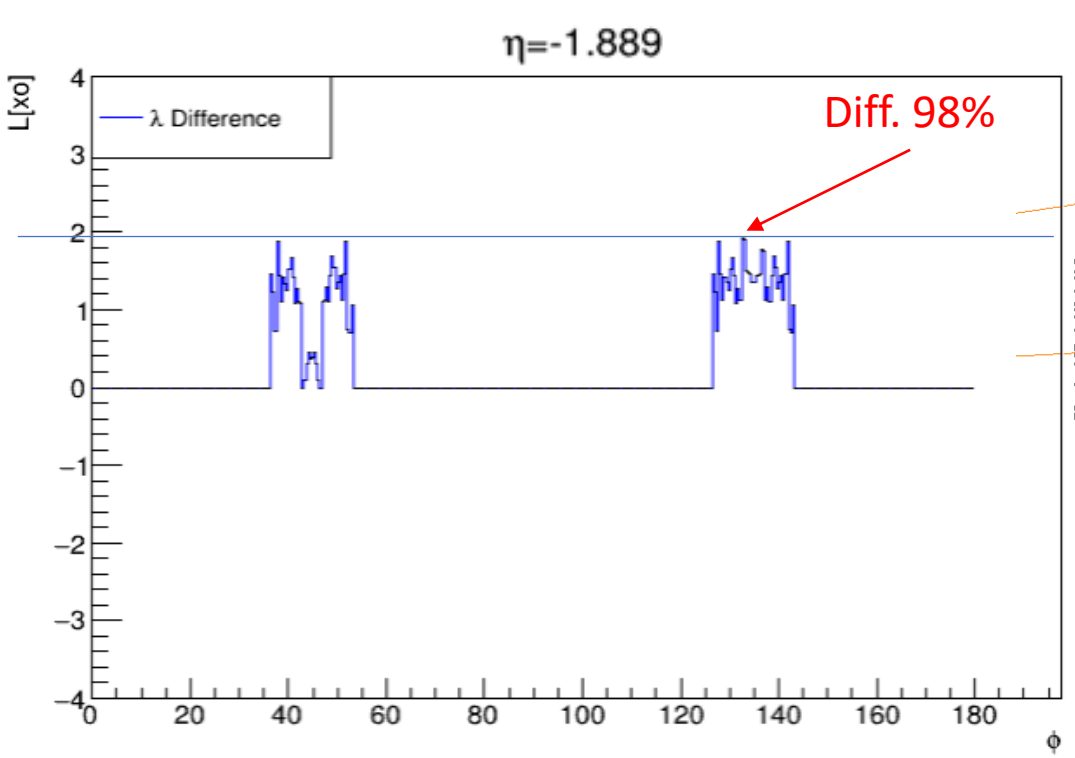
$\eta = -2.611$

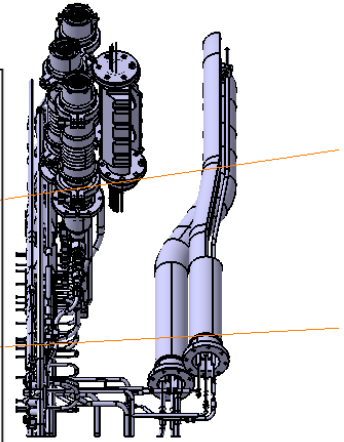
$\eta = -3.4601$

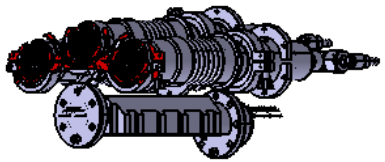
$38 < \Phi < 135.2$

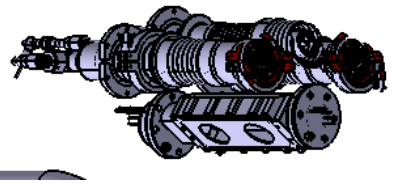
Compare Analyses – Radiation Length L(Xo)





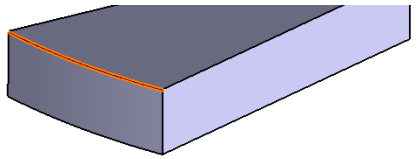


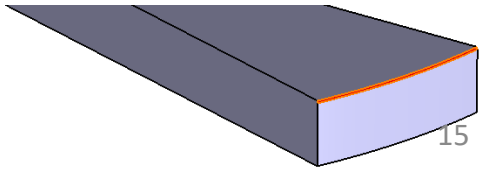




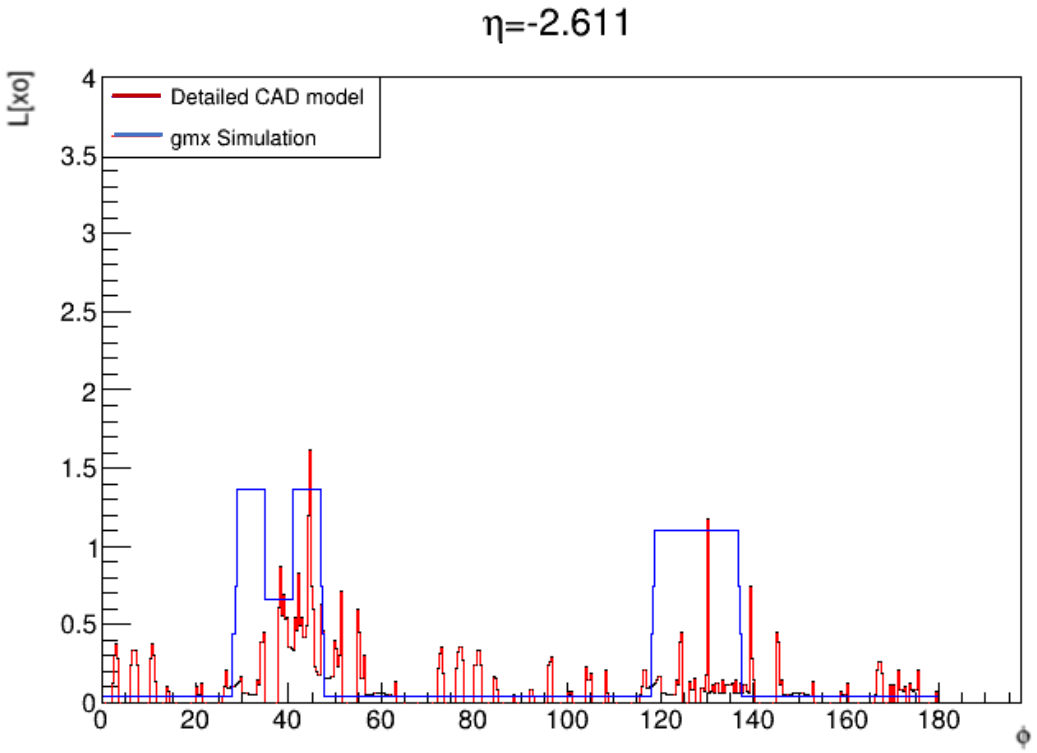
Detailed CAD Model

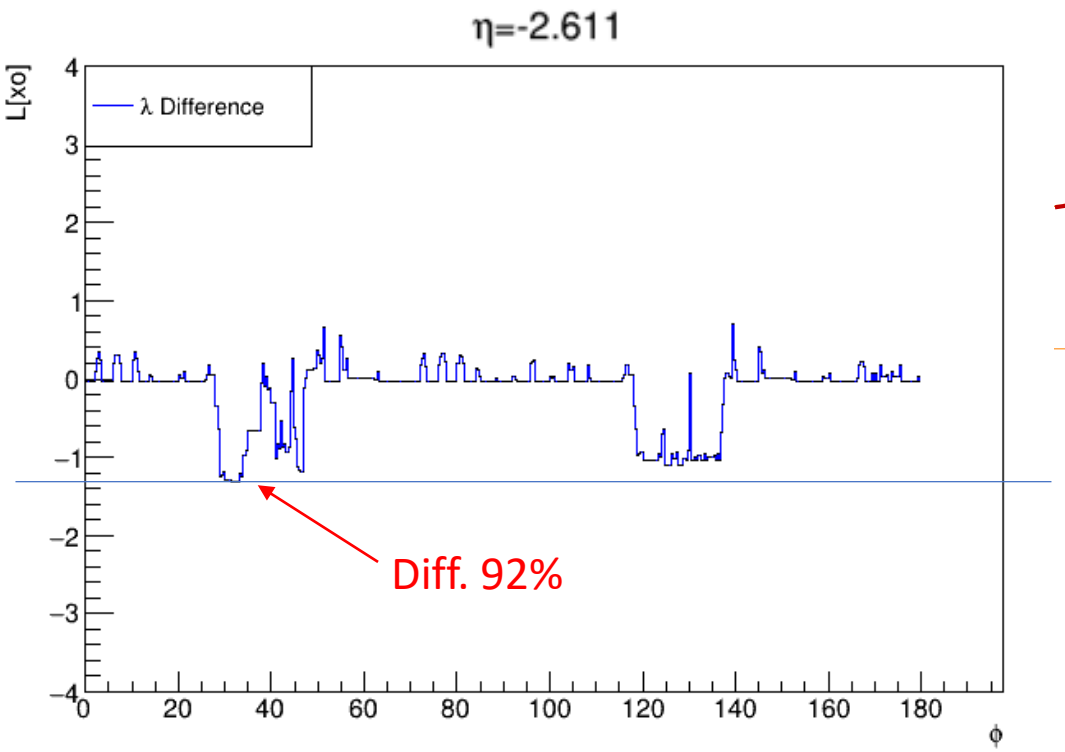
GMX Simulation

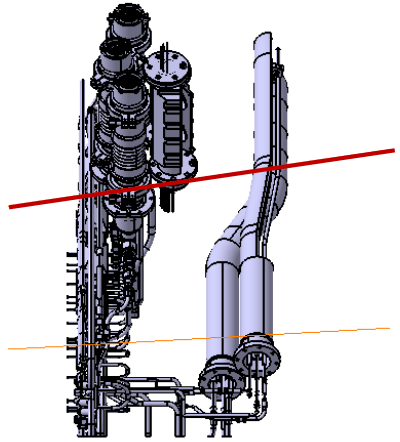




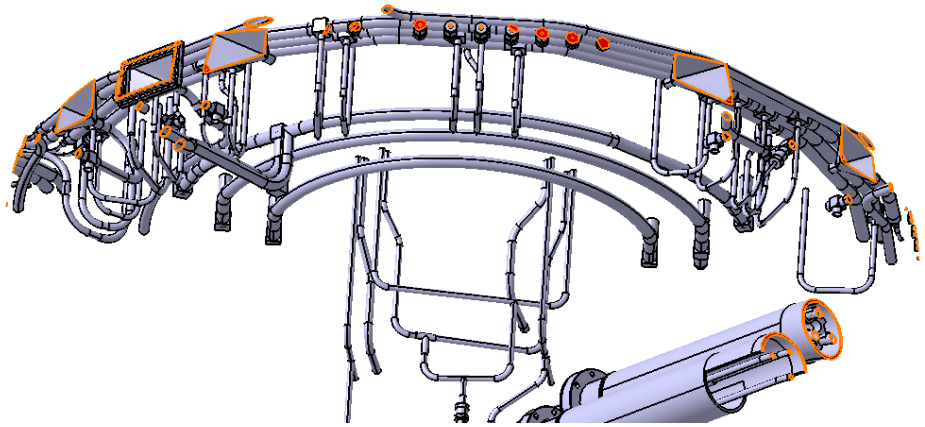
Compare Analyses – Radiation Length L(Xo)



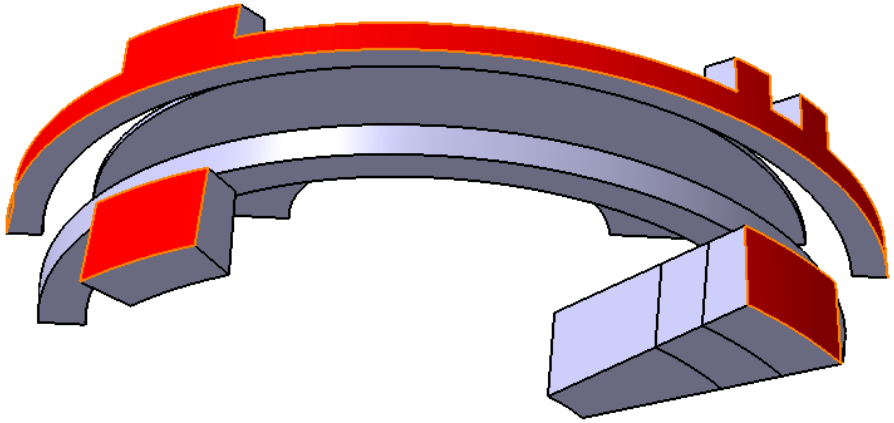




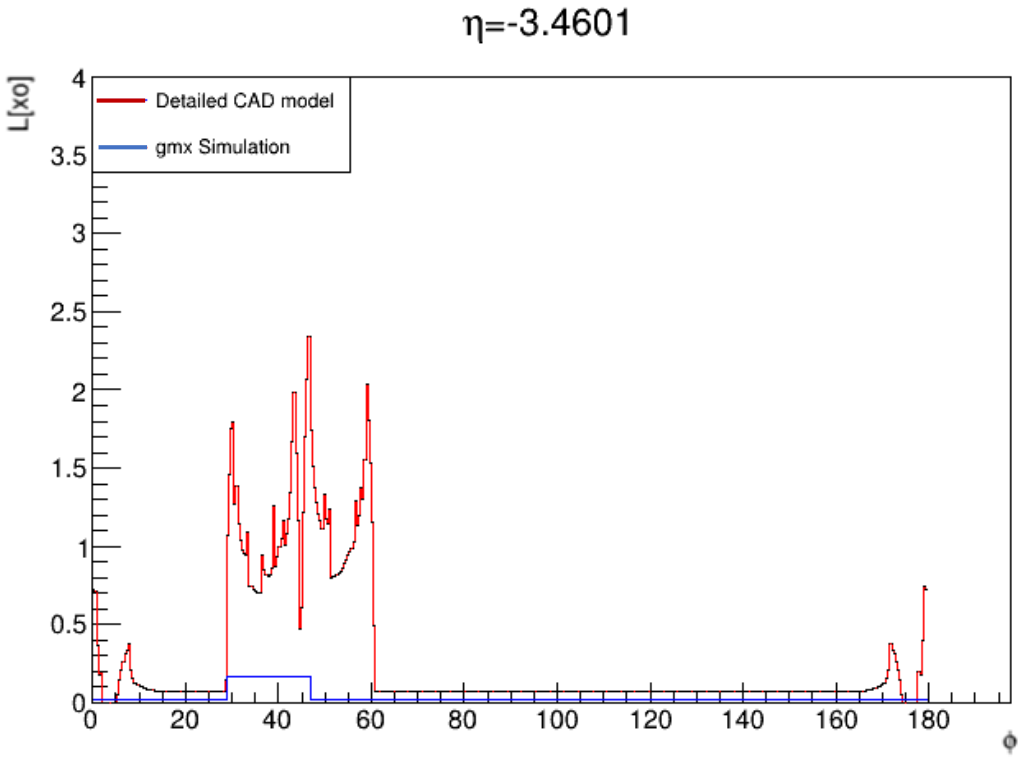
Detailed CAD Model

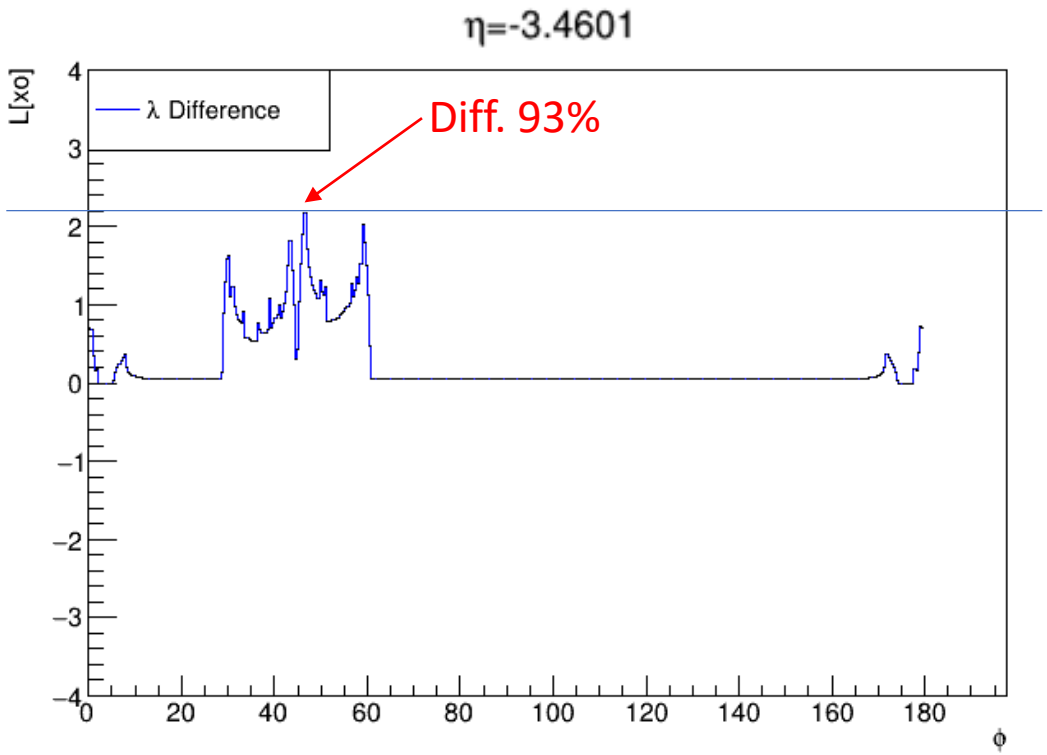


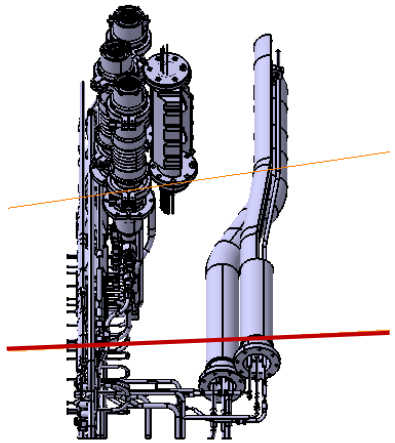
GMX Simulation

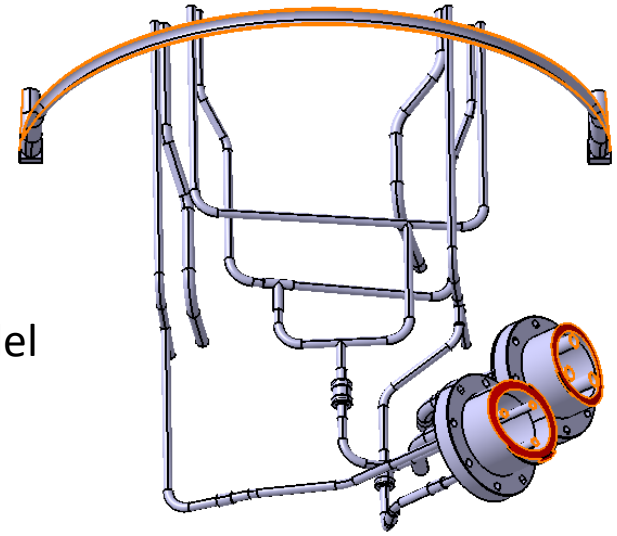


Compare Analyses – Radiation Length L(Xo)



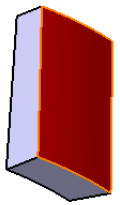






Detailed CAD Model

GMX Simulation

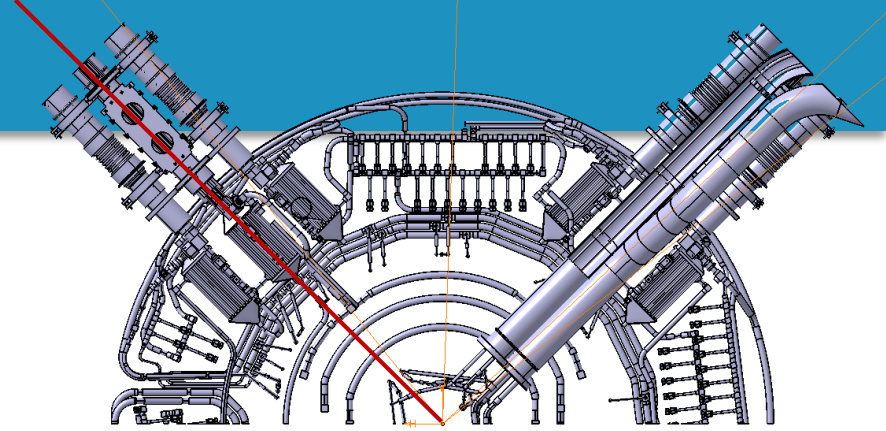


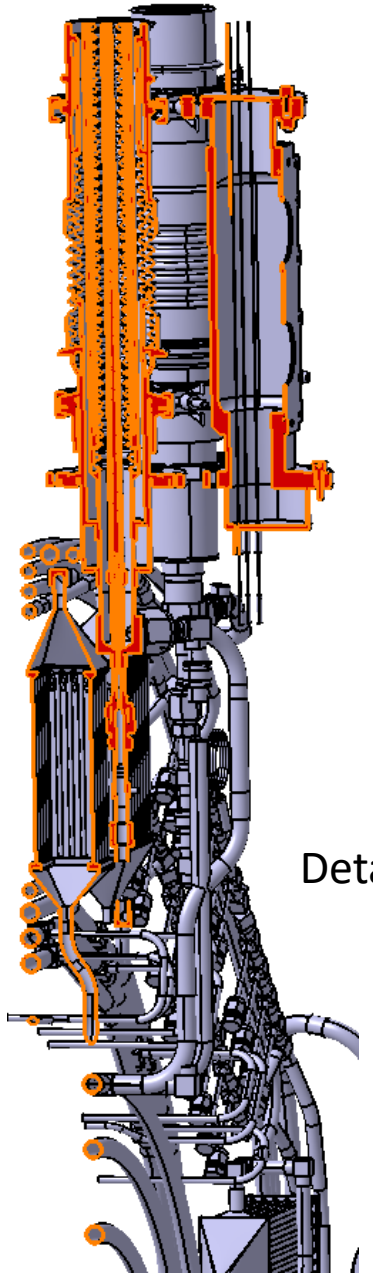
Calculation of Radiation Length (Xo)

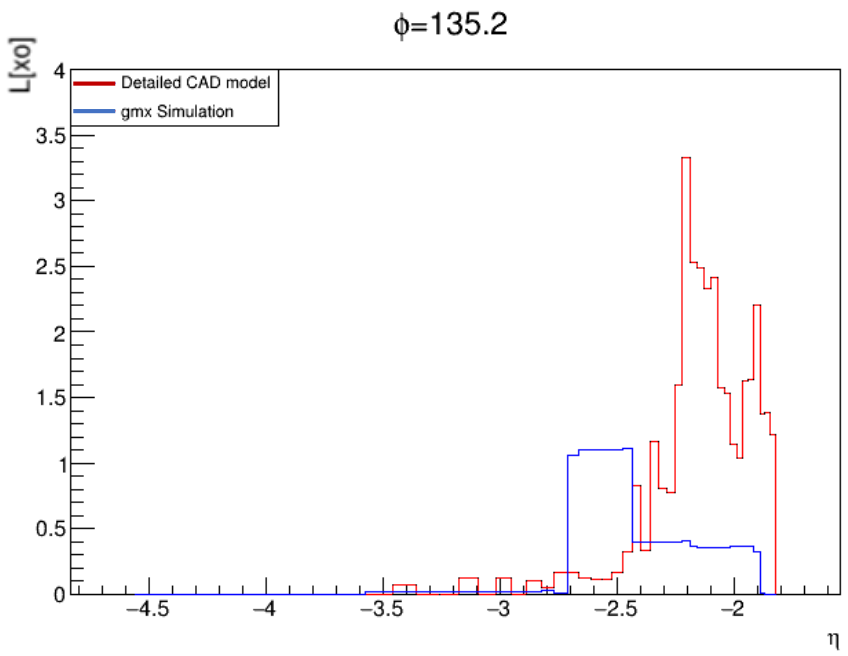
$\Phi = 38$
$\Phi = 42.8$
$\Phi = 88$
$\Phi = 128.8$
$\Phi = 135.2$

$-1.82 > \eta > -4.55$

Compare Analyses – Radiation Length L(Xo)

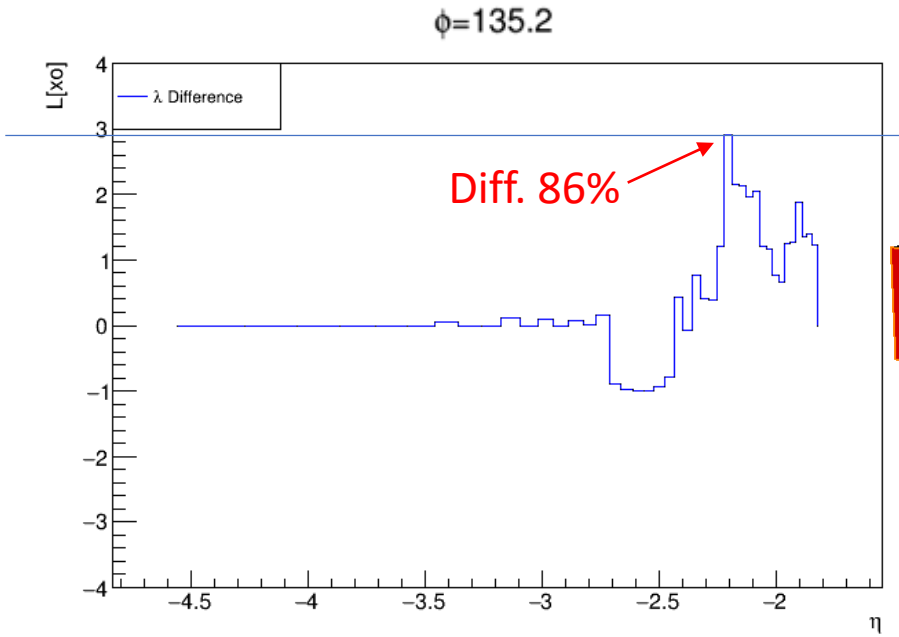


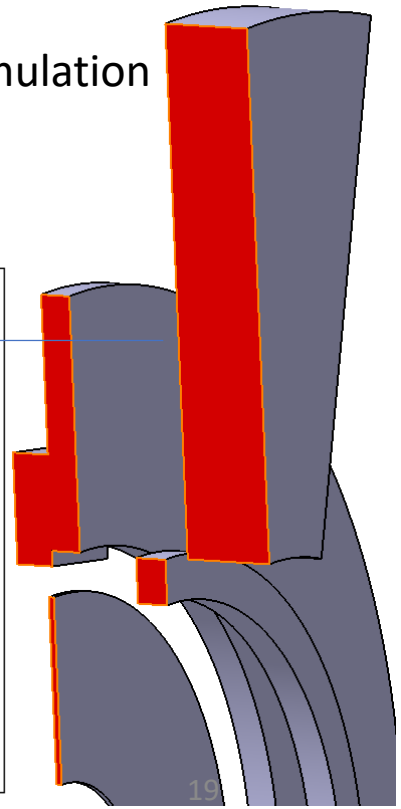




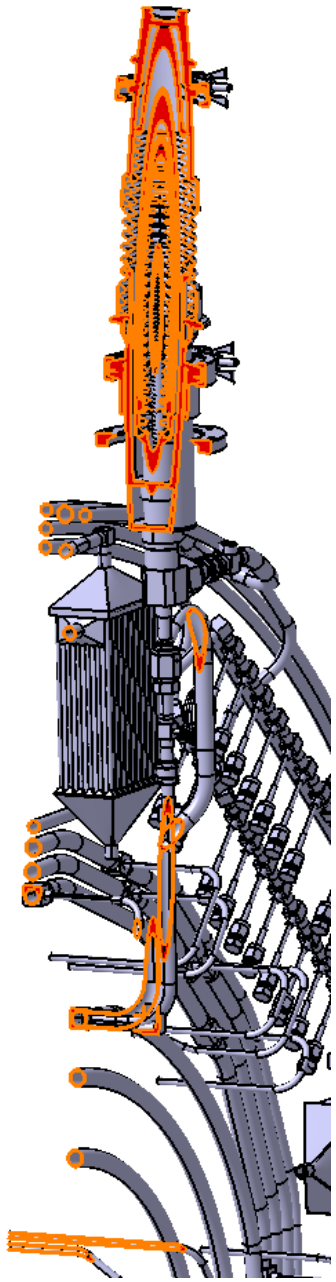
Detailed CAD Model

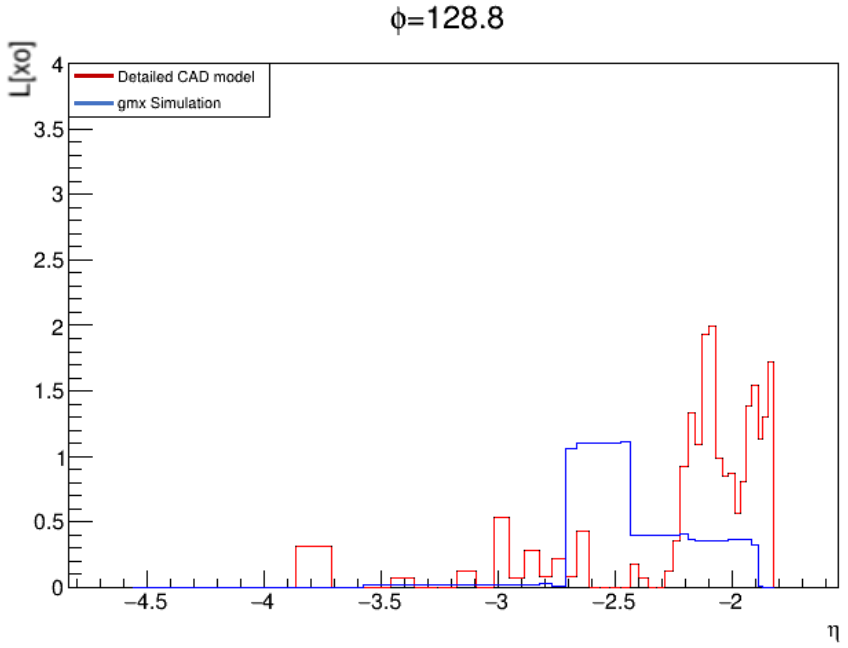
GMX Simulation

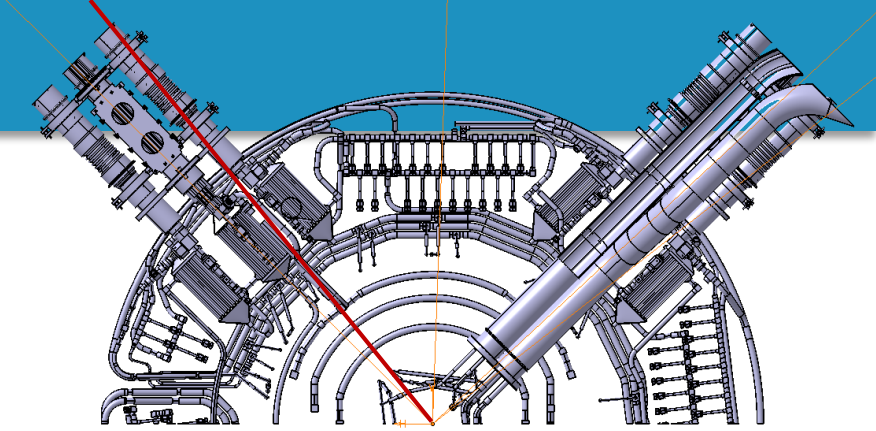




Compare Analyses – Radiation Length L(Xo)

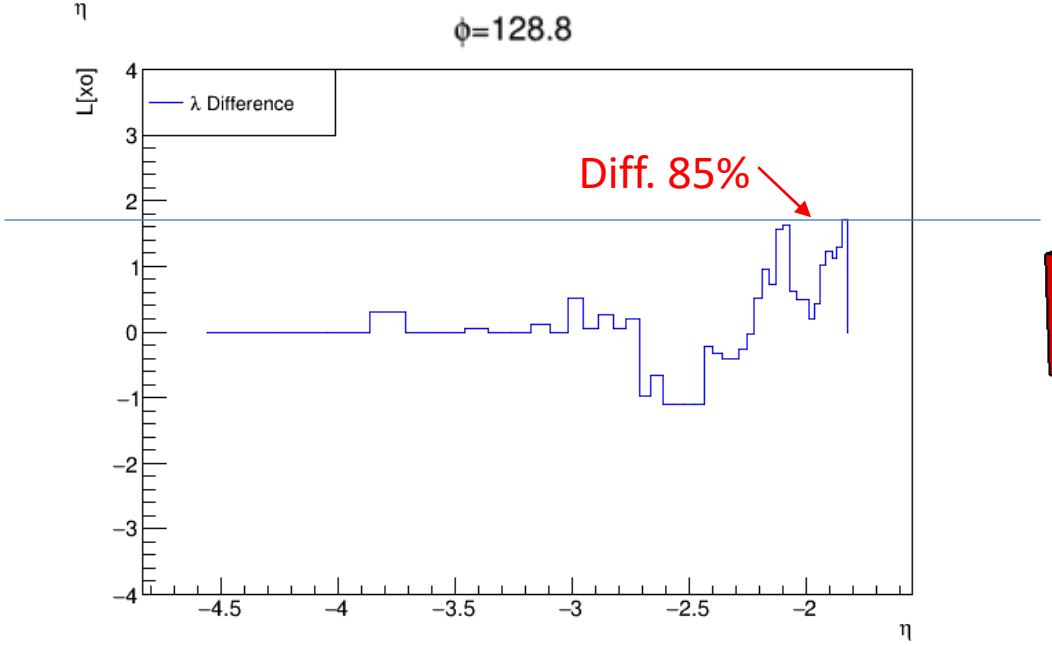


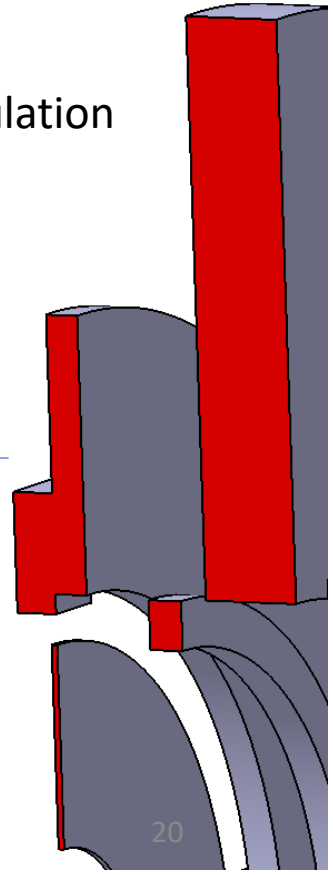




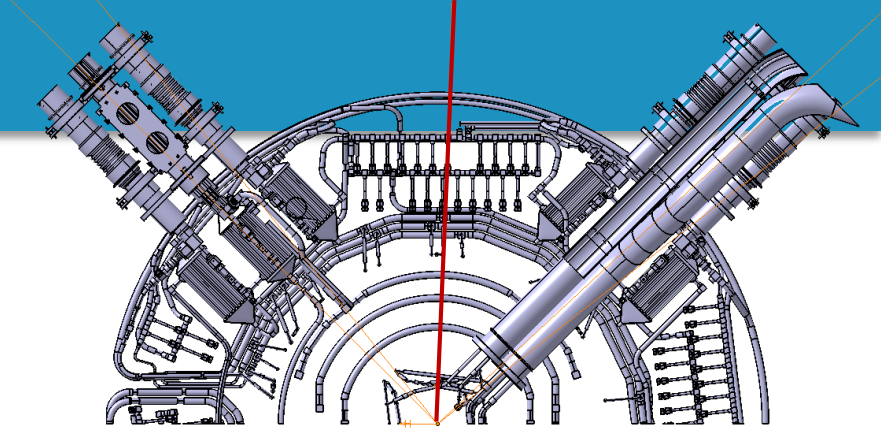
Detailed CAD Model

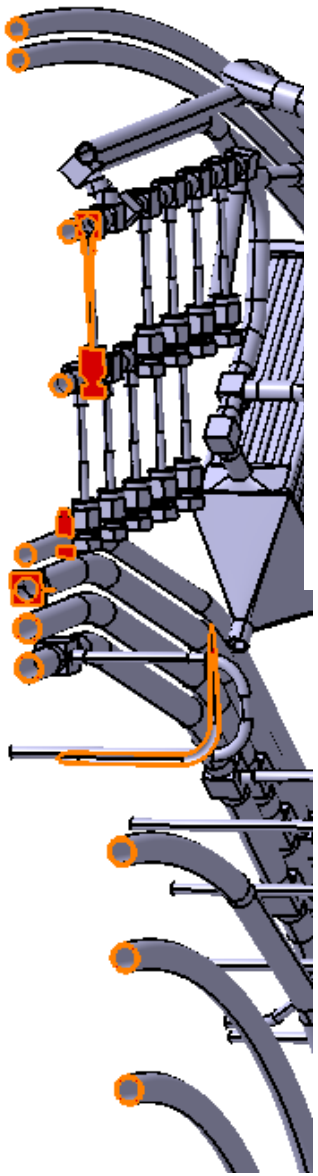
GMX Simulation

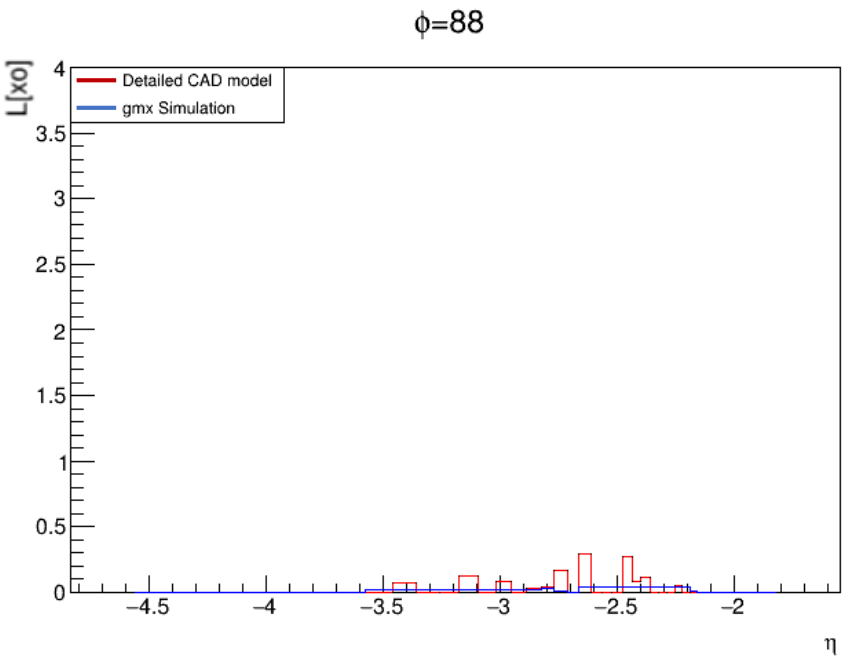




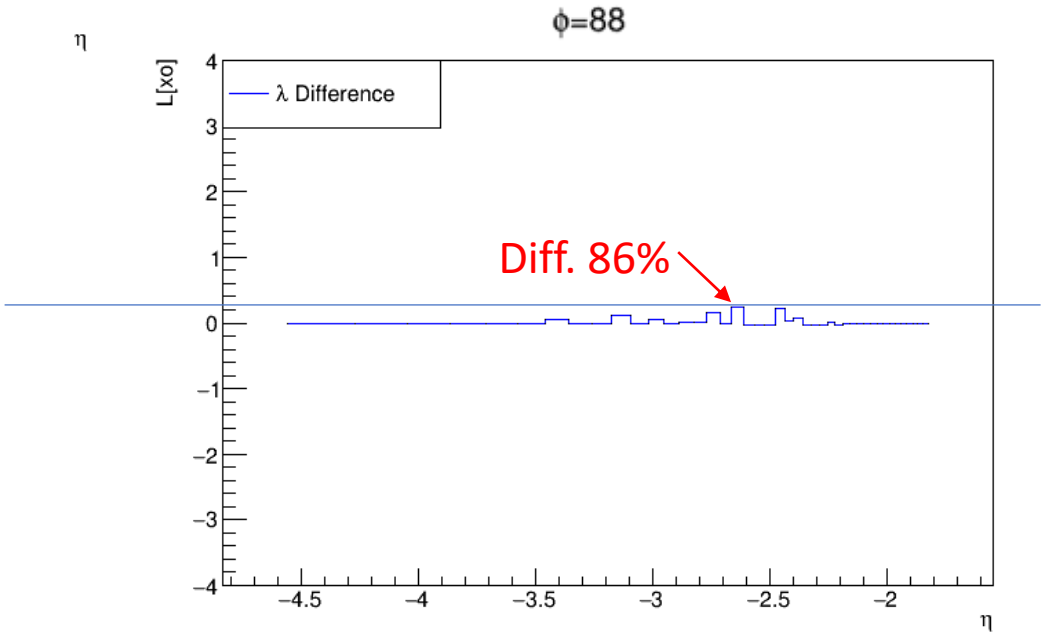
Compare Analyses – Radiation Length L(Xo)



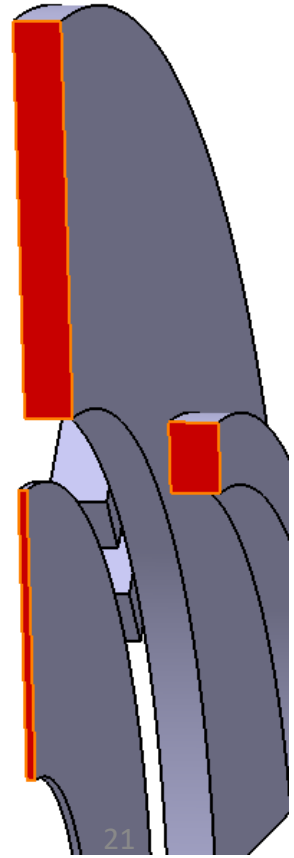




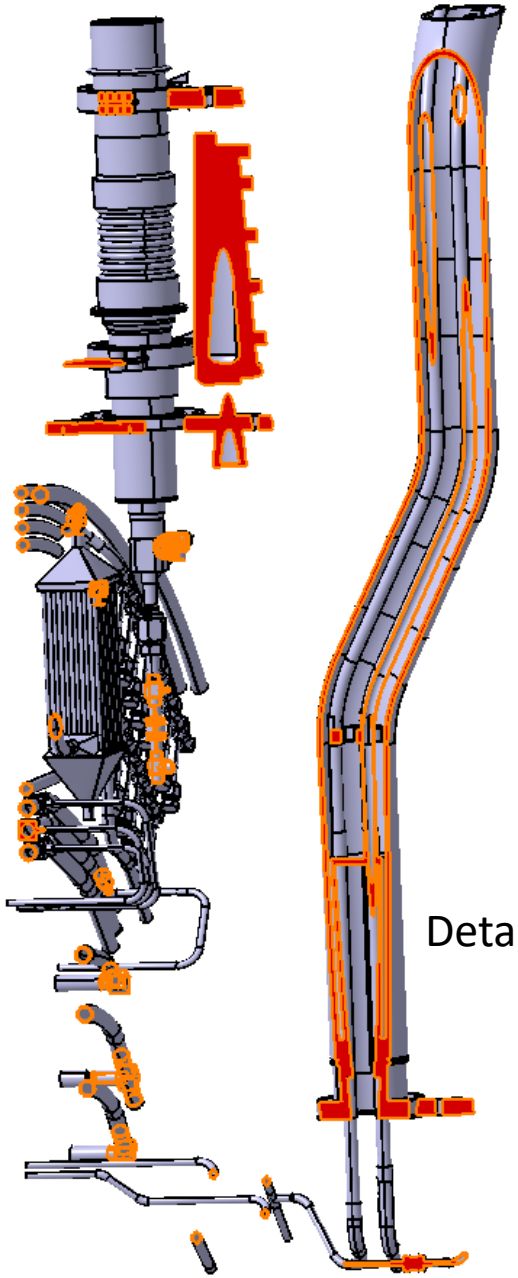
Detailed CAD Model



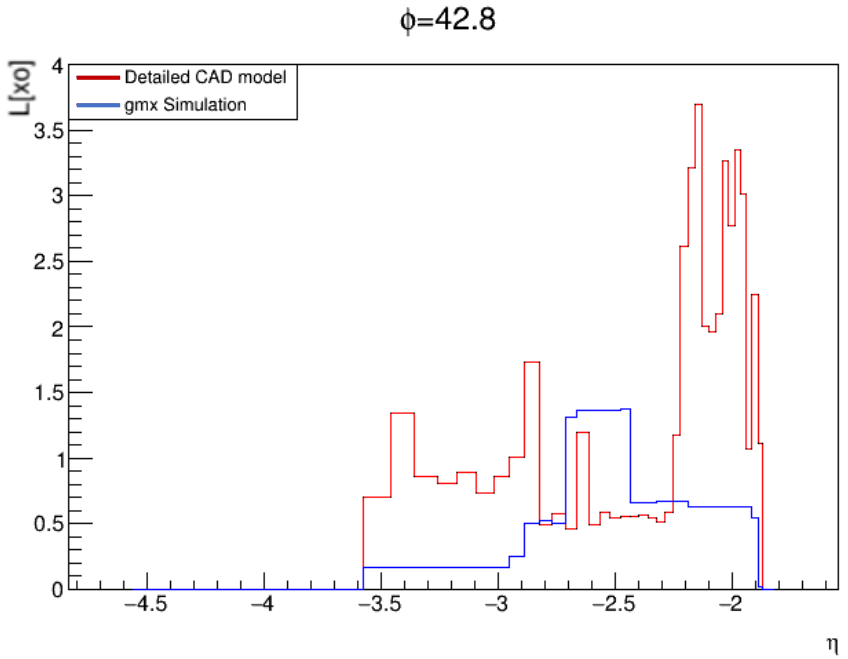
GMX Simulation

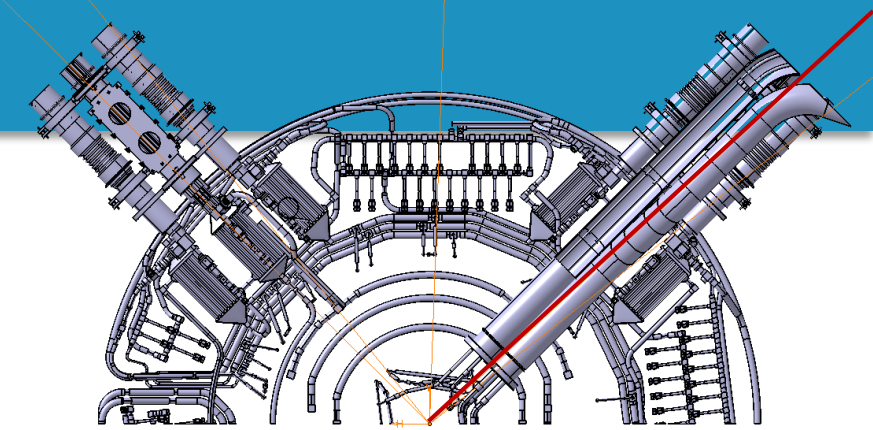


Compare Analyses – Radiation Length L(Xo)

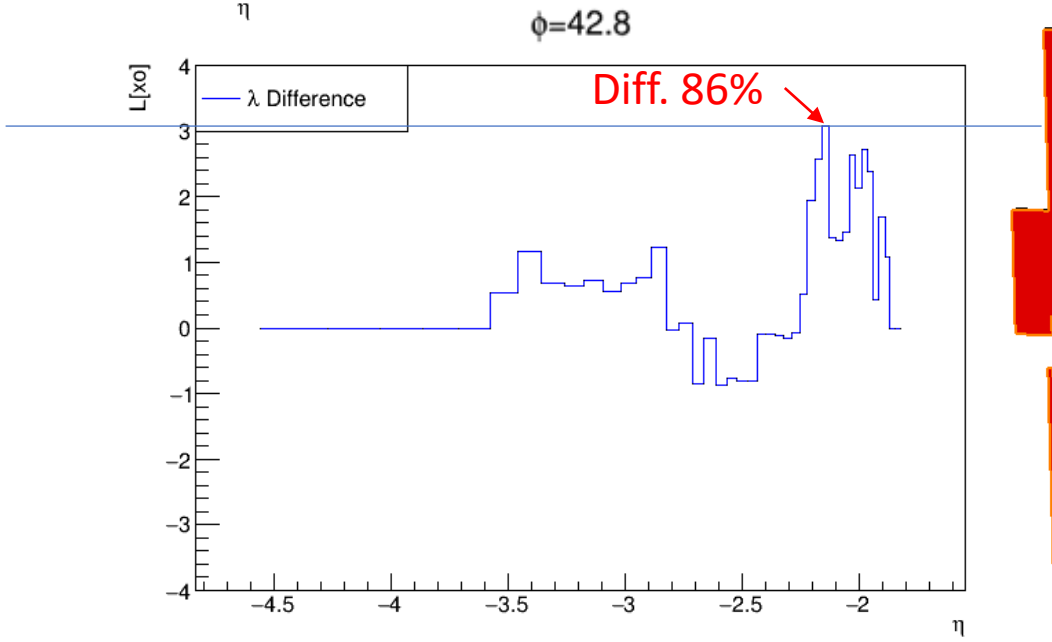


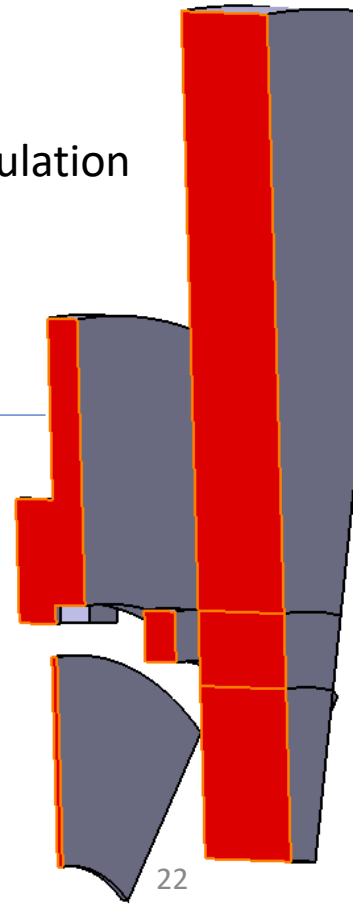
Detailed CAD Model



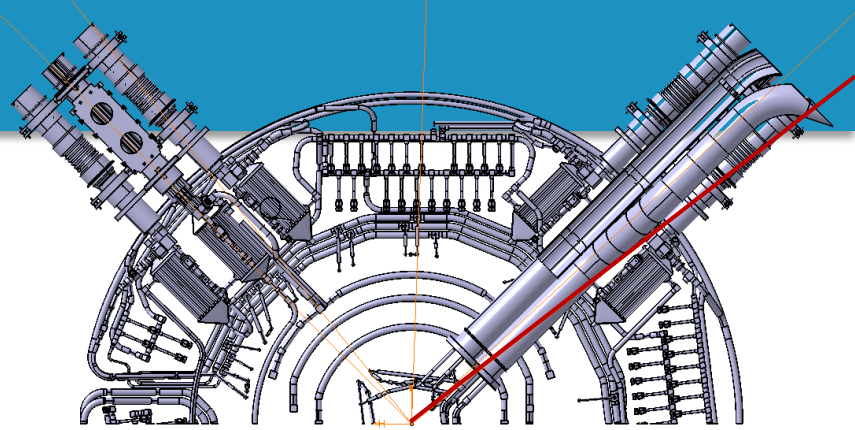


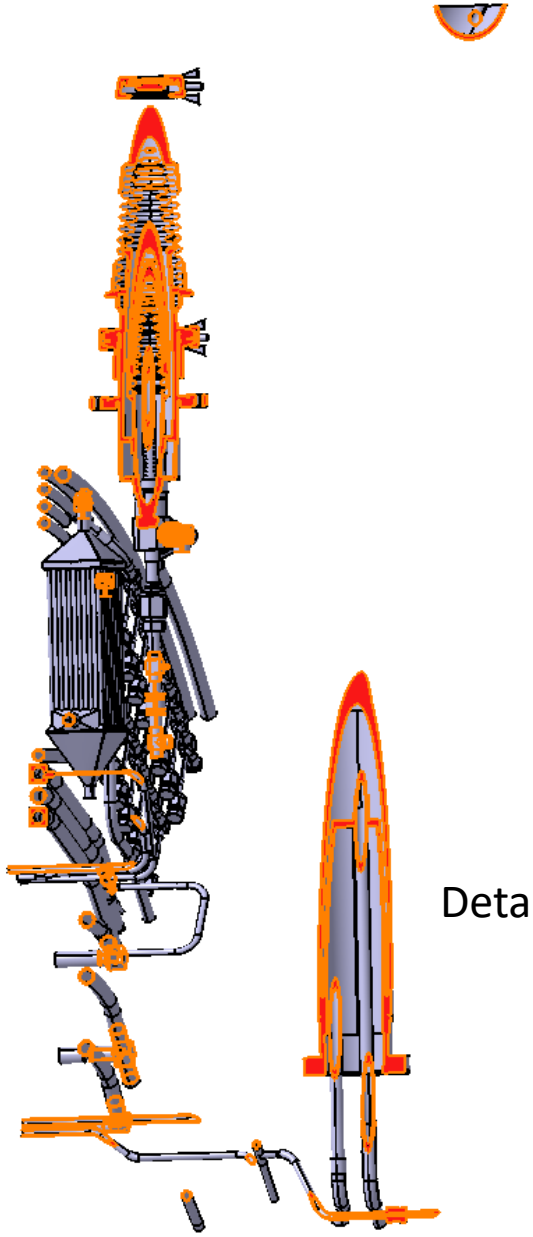
GMX Simulation



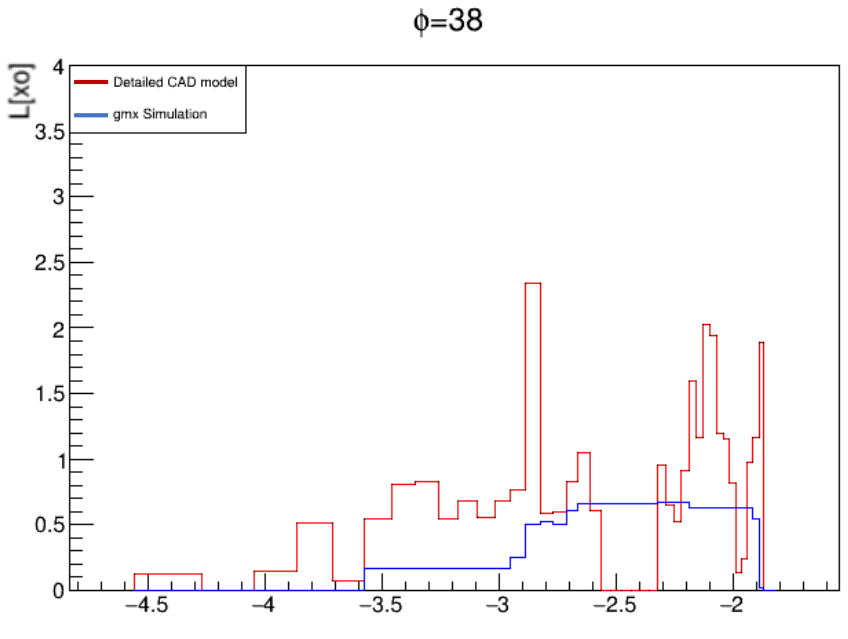


Compare Analyses – Radiation Length L(Xo)

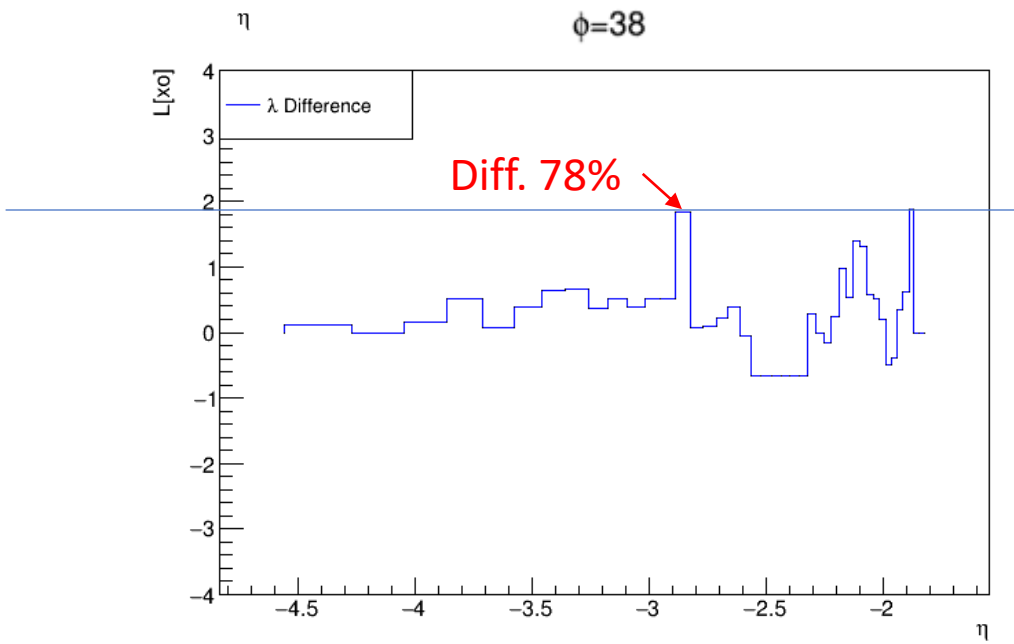


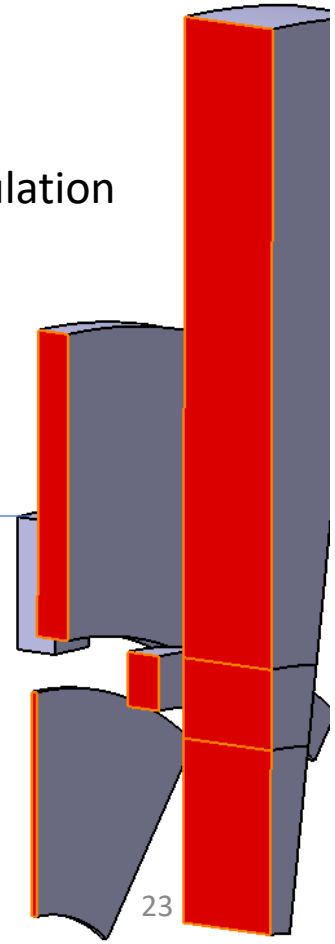


Detailed CAD Model



GMX Simulation



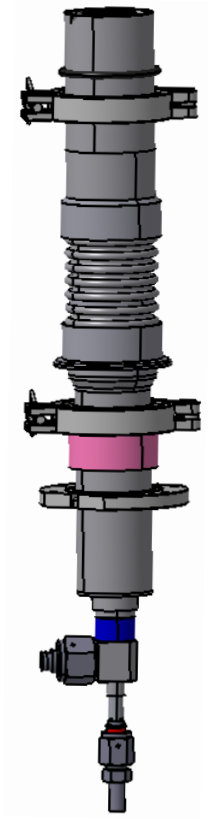


3. Simplification of the Detailed CAD Model

Assembly 1 - Detailed CAD Model vs. Simplified CAD Model

Detailed CAD Model

Flex Line (12x)



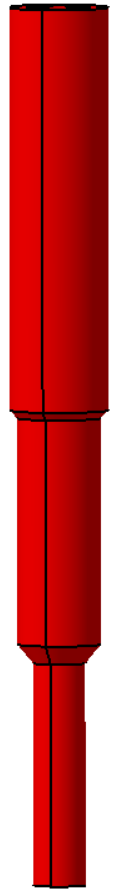
Dif. Flex Line (2x)

		Total Volume (m3)	Weight (kg)	Total Volume (m3)	Weight (kg)
1	Flex Line	0.006596	52.7	0.006584	52.67
2	Dif. Flex Line	0.000656	5.2	0.000655	5.24

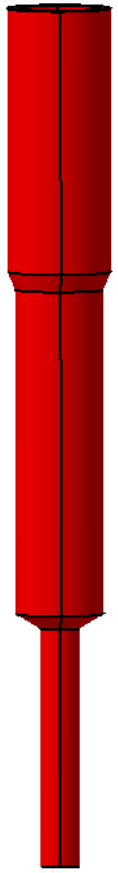
Diff. 0.01

Simplified CAD Model

Flex Line (12x)



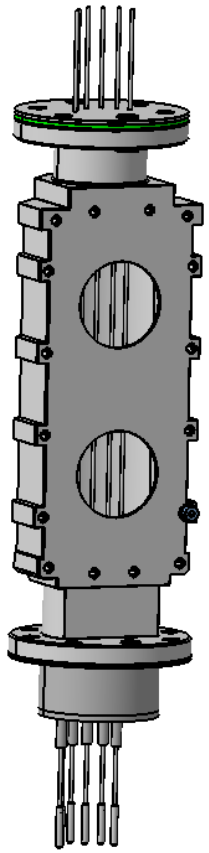
Dif. Flex Line (2x)



Assembly 1 - Detailed CAD Model vs. Simplified CAD Model

Detailed CAD Model

Feed-Through (2x)

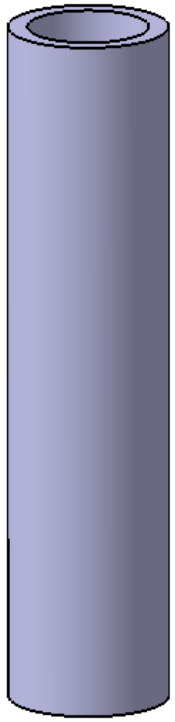


		Total Volume (m3)	Weight (kg)	Total Volume (m3)	Weight (kg)
1	Feed-Through	0.000865	6.9	0.000859	6.87

Diff. -0.03

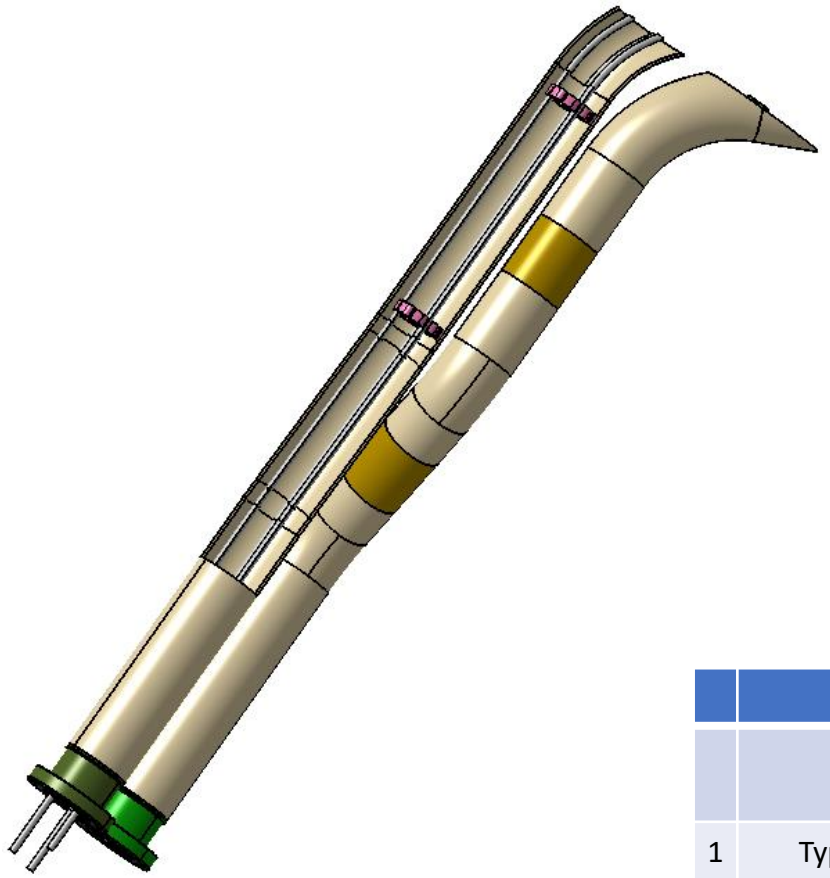
Simplified CAD Model

Feed-Through (2x)

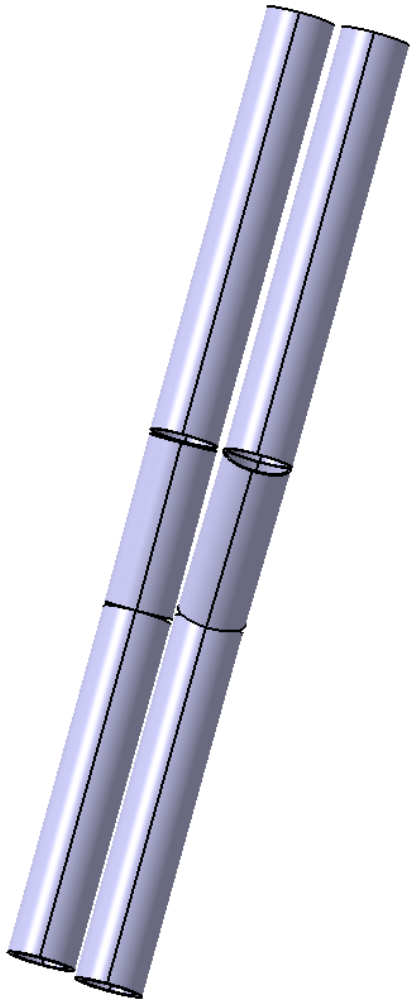


Assembly 1 - Detailed CAD Model vs. Simplified CAD Model

Detailed CAD Model



Simplified CAD Model



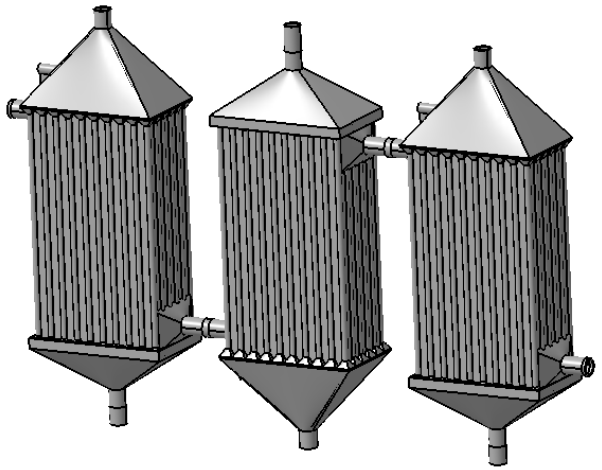
		Total Volume (m3)	**Weight (kg)**	**Total Volume (m3)**	**Weight (kg)**
1	Type2 Cooling	0.001254	10	0.001246	9.97

Diff. -0.03

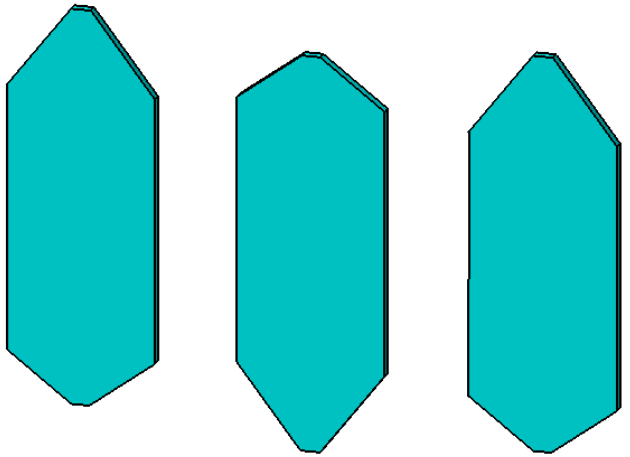
Assembly 2 - Detailed CAD Model vs. Simplified CAD Model

Detailed CAD Model

Warm Nose(11x)



Simplified CAD Model

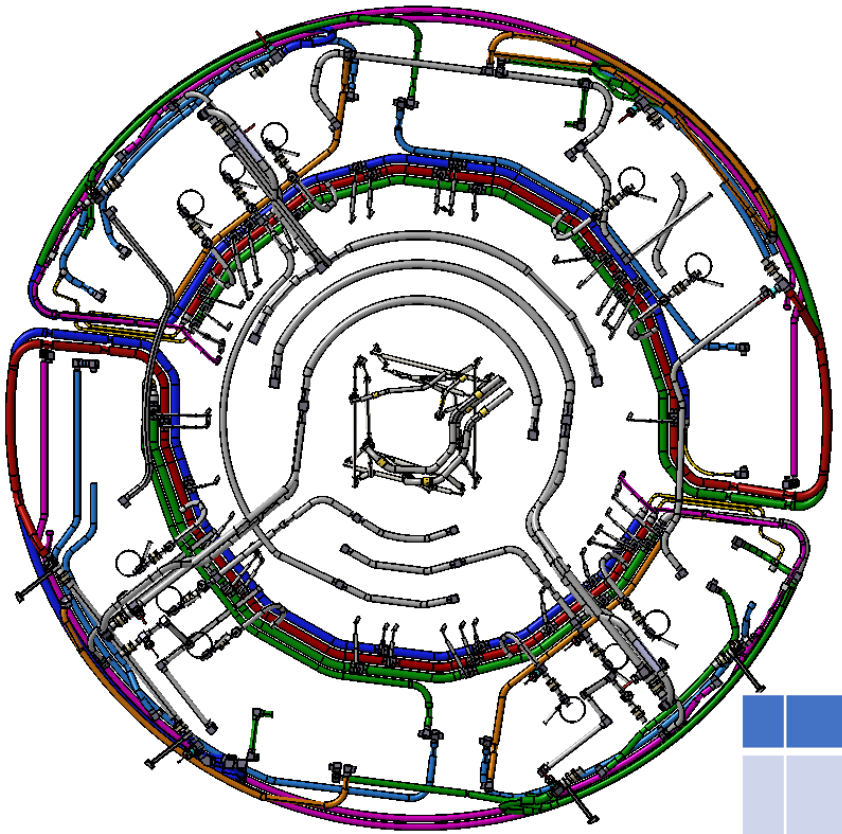


		Total Volume (m3)	Weight (kg)	Total Volume (m3)	Weight (kg)
1	Warm Nose	0.000742	3.34	0.000735	3.31

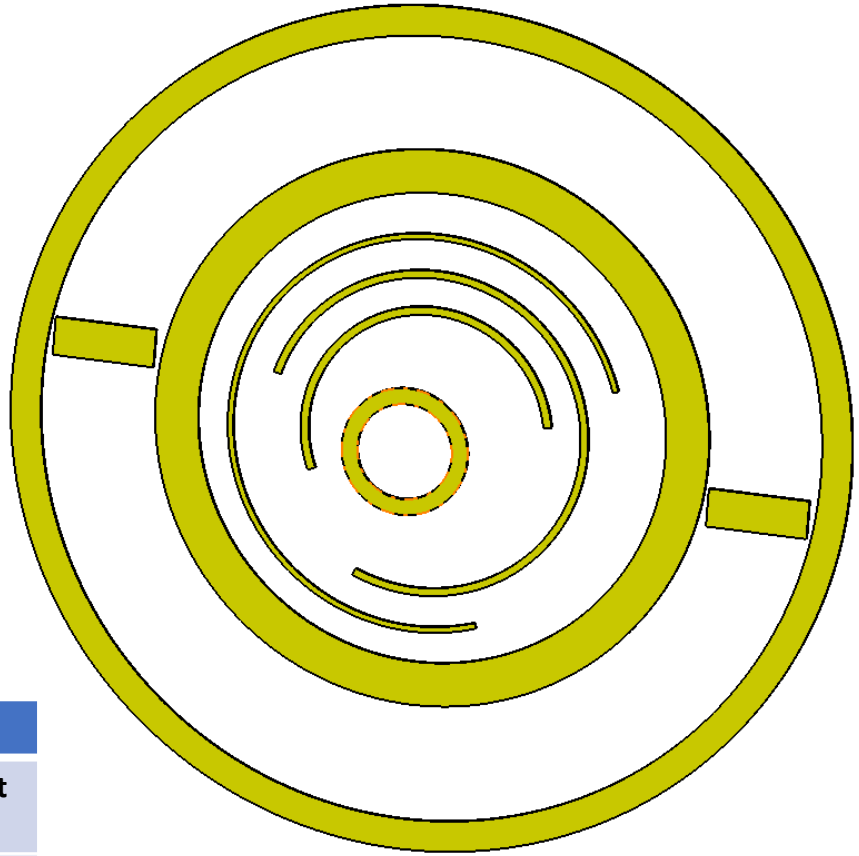
Diff. -0.03

Assembly 2 - Detailed CAD Model vs. Simplified CAD Model

Detailed CAD Model



Simplified CAD Model

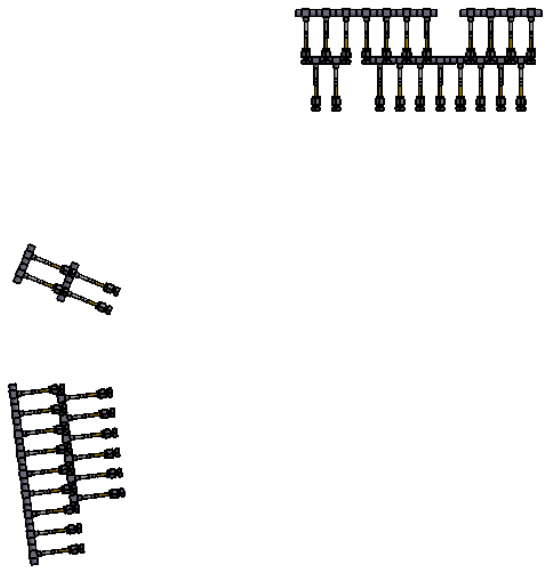


		Total Volume (m3)	Weight (kg)	Total Volume (m3)	Weight (kg)
1	Pipes / Connectors	0.002259	10.16	0.002268	10.2

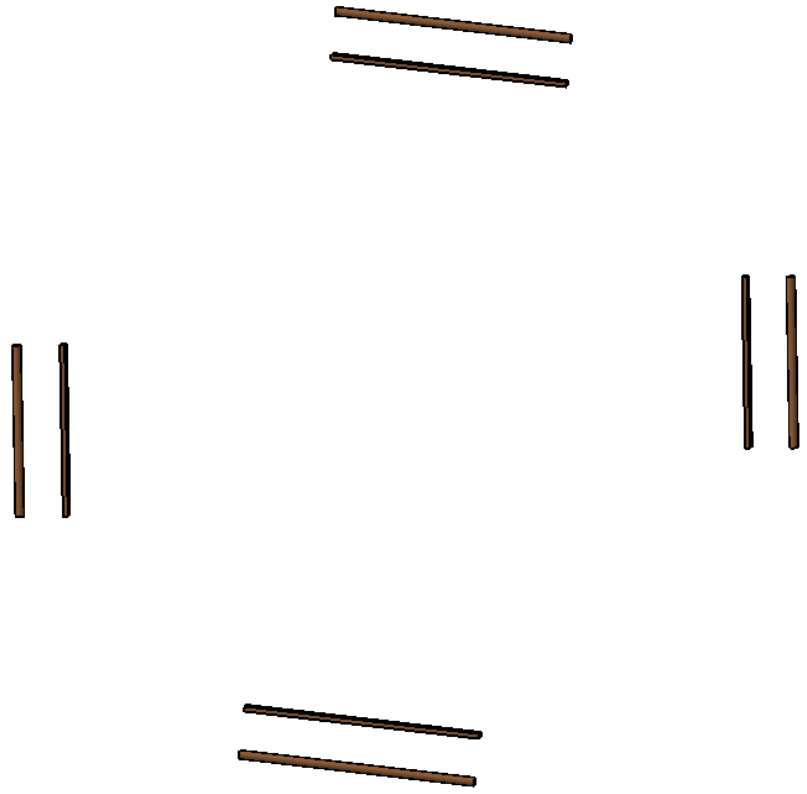
Diff. +0.04

Assembly 2 - Detailed CAD Model vs. Simplified CAD Model

Detailed CAD Model



Simplified CAD Model

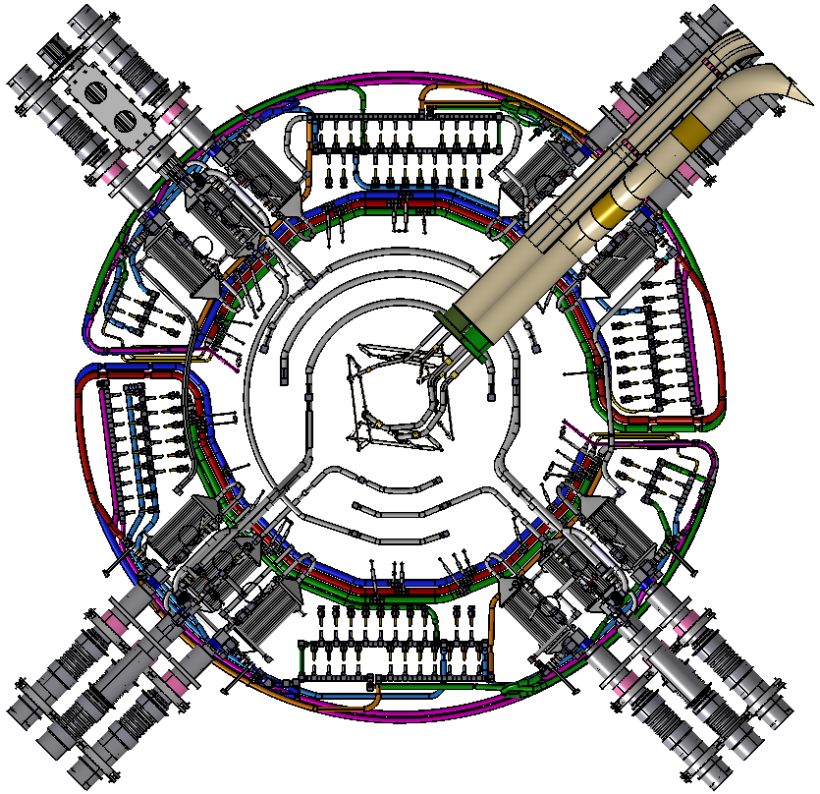


		Total Volume (m3)	Weight (kg)	Total Volume (m3)	Weight (kg)
1	Capillary Manifold	0.000327	1.47	0.000322	1.45

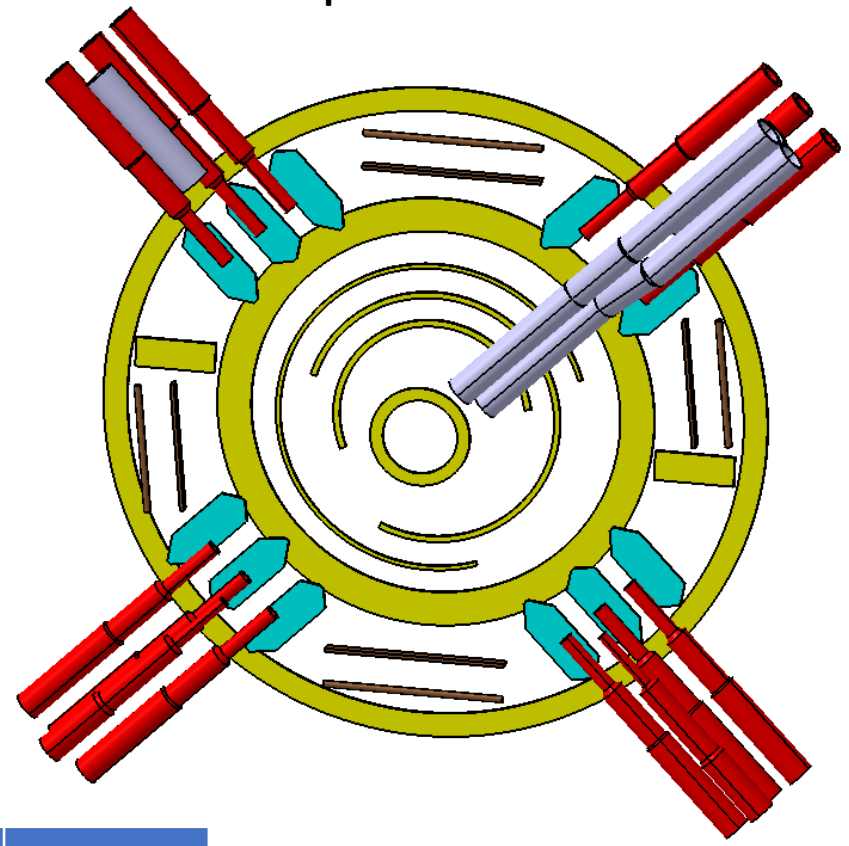
Diff. -0.02

Compare Analyses - GMX Description Vs. Detailed CAD Model

Detailed CAD Model



Simplified CAD Model



	Detailed CAD Model		Simplified CAD Model		
Name	Volume (m3)	Weight (kg)	Total Volume (m3)	Weight (kg)	Diff. (kg)
Assembly 1	0.009371	74.8	0.009344	74.75	-0.05
Assembly 2	0.003328	14.97	0.003325	14.96	-0.01

4. Preparation of GMX Description

Preparation of GMX Description

```
<!-- Pipes Assembly -->
  <tube name="Pipe_Part1" rmin="Pipe_Part1_rmi" rmax="Pipe_Part1_rma" zhalflength="Pipe_z"/>
  <tube name="Pipe_Part2" rmin="Pipe_Part2_rmi" rmax="Pipe_Part2_rma" zhalflength="Pipe_z"/>
  <tube name="Pipe_Part3" rmin="Pipe_Part3_rmi" rmax="Pipe_Part3_rma" zhalflength="Pipe_z"/>
  <tubs name="Pipe_Part4_1" rmin="Pipe_Part4_1_rmi" rmax="Pipe_Part4_1_rma" zhalflength="Pipe_z" sphi="19.1362*DtoR" dphi="270*DtoR"/>
  <tubs name="Pipe_Part4_2" rmin="Pipe_Part4_2_rmi" rmax="Pipe_Part4_2_rma" zhalflength="Pipe_z" sphi="247.544*DtoR" dphi="277.3555*DtoR"/>
  <tubs name="Pipe_Part4_3" rmin="Pipe_Part4_3_rmi" rmax="Pipe_Part4_3_rma" zhalflength="Pipe_z" sphi="9.4696*DtoR" dphi="194.6*DtoR"/>
  <box name="Pipe_Part5" xhalflength="Pipe_Part5_rmi"  yhalflength="Pipe_Part5_rma" zhalflength="Pipe_z"/>
<!-- End Pipes Assembly -->

<!-- Type2Cooling -->
  <tube name="Type2Cooling_Part1" rmin="Type2Cooling_Part1_rmi" rmax="Type2Cooling_Part1_rma" zhalflength="Type2Cooling_Part1_z"/>
  <tube name="Type2Cooling_Part2" rmin="Type2Cooling_Part2_rmi" rmax="Type2Cooling_Part2_rma" zhalflength="Type2Cooling_Part2_z"/>
  <tube name="Type2Cooling_Part3" rmin="Type2Cooling_Part2_rmi" rmax="Type2Cooling_Part2_rma" zhalflength="Type2Cooling_Part3_z"/>

  <tube name="Type2Cooling_Part4" rmin="Type2Cooling_Part1_rmi" rmax="Type2Cooling_Part1_rma" zhalflength="Type2Cooling_Part4_z"/>
  <tube name="Type2Cooling_Part5" rmin="Type2Cooling_Part2_rmi" rmax="Type2Cooling_Part2_rma" zhalflength="Type2Cooling_Part2_z"/>
  <tube name="Type2Cooling_Part6" rmin="Type2Cooling_Part6_rmi" rmax="Type2Cooling_Part2_rma" zhalflength="Type2Cooling_Part3_z"/>
<!-- End Type2Cooling -->
</shapes>


  <logvol name="Flex_line" shape="Flex_line_main" material="SS304L" />
  <logvol name="Flex_line_Special" shape="Flex_line_Special_main" material="SS304L" />

  <logvol name="Capillary_Manifold_BoxLong_Log" shape="Capillary_Manifold_BoxLong" material="TitaniumPP1Cool" />
  <logvol name="Capillary_Manifold_TubeLong_Log" shape="Capillary_Manifold_TubeLong" material="TitaniumPP1Cool" />
  <logvol name="Capillary_Manifold_BoxShort_Log" shape="Capillary_Manifold_BoxShort" material="TitaniumPP1Cool" />
  <logvol name="Capillary_Manifold_TubeShort_Log" shape="Capillary_Manifold_TubeShort" material="TitaniumPP1Cool" />

  <logvol name="feed_through_Log" shape="feed_through" material="SS304L" />

  <logvol name="Warm_Nose_Log" shape="Warm_Nose" material="TitaniumPP1Cool" />

  <logvol name="Pipe_Part1_Log" shape="Pipe_Part1" material="TitaniumPP1Cool" />
  <logvol name="Pipe_Part2_Log" shape="Pipe_Part2" material="TitaniumPP1Cool" />
  <logvol name="Pipe_Part3_Log" shape="Pipe_Part3" material="TitaniumPP1Cool" />
  <logvol name="Pipe_Part4_1_Log" shape="Pipe_Part4_1" material="TitaniumPP1Cool" />
  <logvol name="Pipe_Part4_2_Log" shape="Pipe_Part4_2" material="TitaniumPP1Cool" />
  <logvol name="Pipe_Part4_3_Log" shape="Pipe_Part4_3" material="TitaniumPP1Cool" />
  <logvol name="Pipe_Part5_Log" shape="Pipe_Part5" material="TitaniumPP1Cool" />
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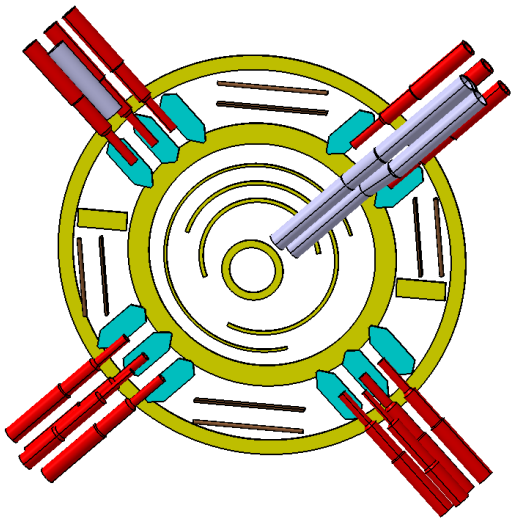
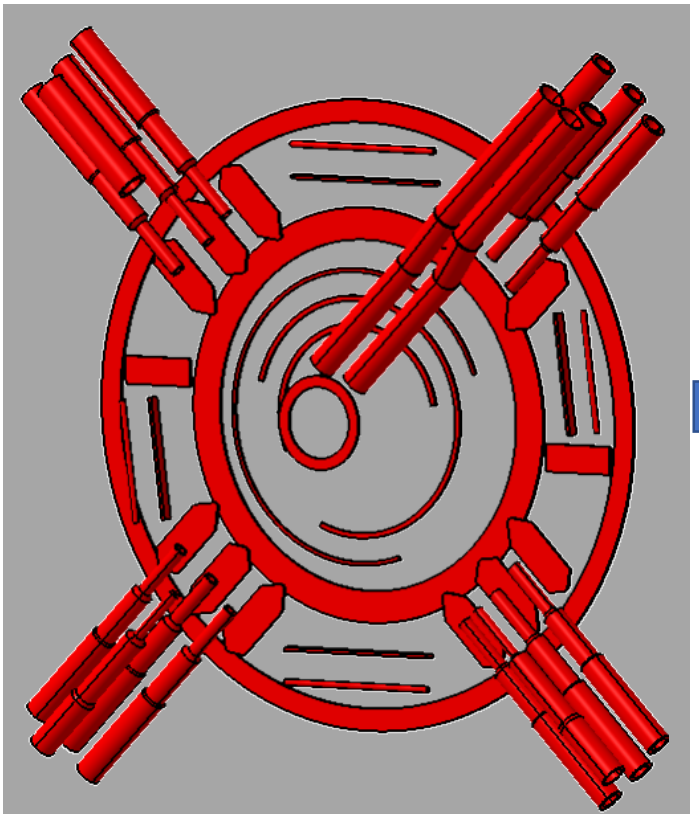


501 Programing strings
19 Solids
0 Boolean Operations

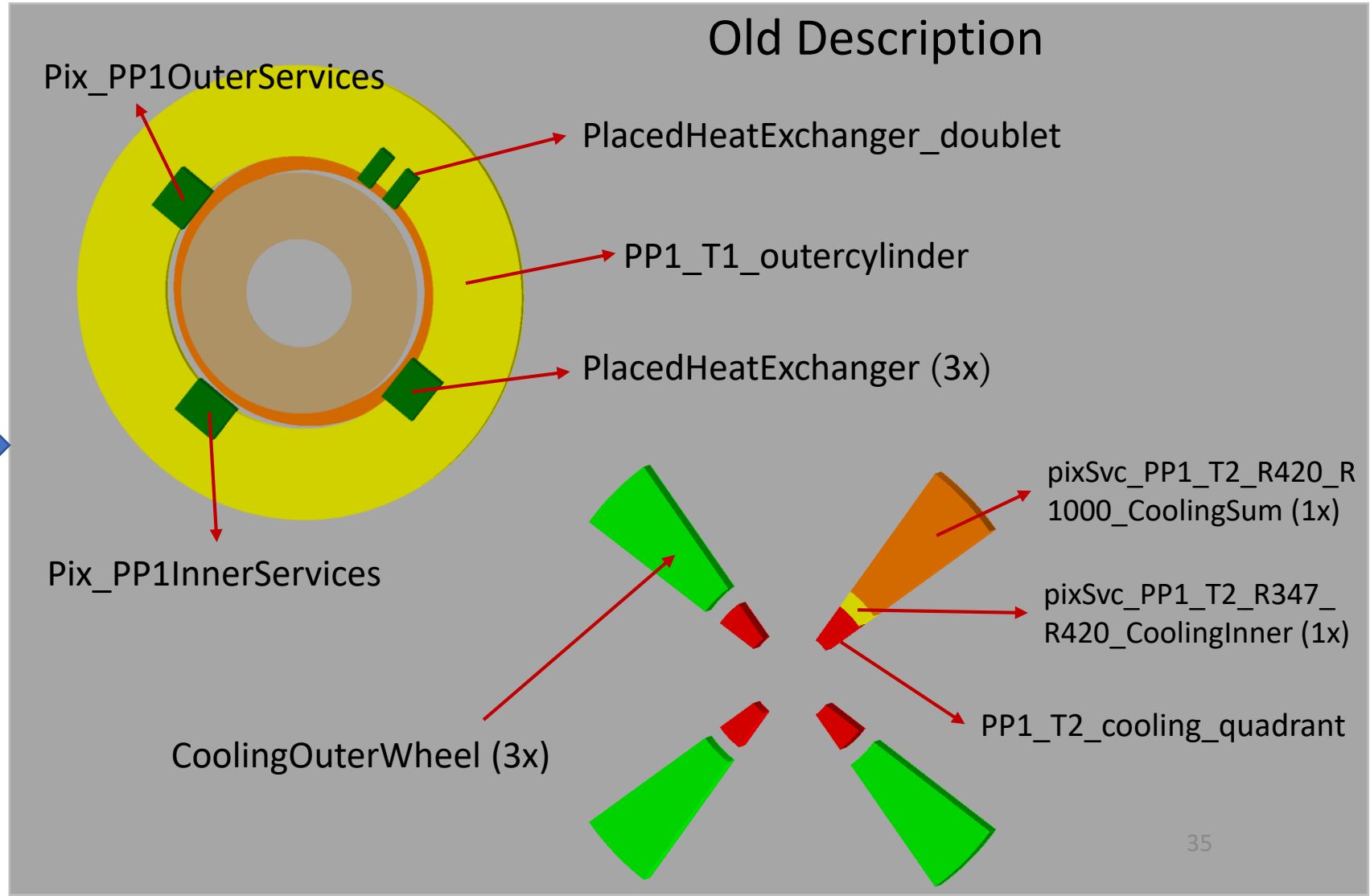
5. Integration Conflicts Checking

Existing Cooling System have to be replaced with new one

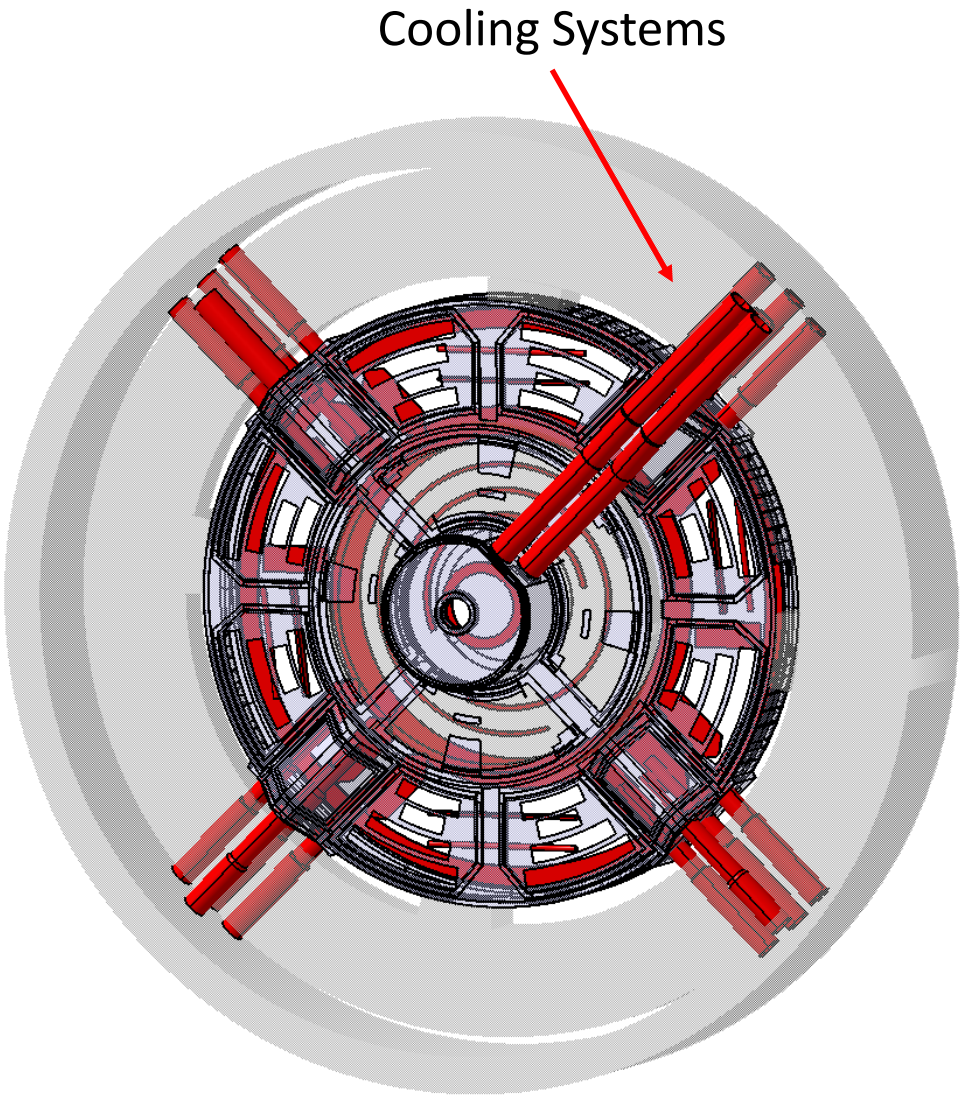
New Description



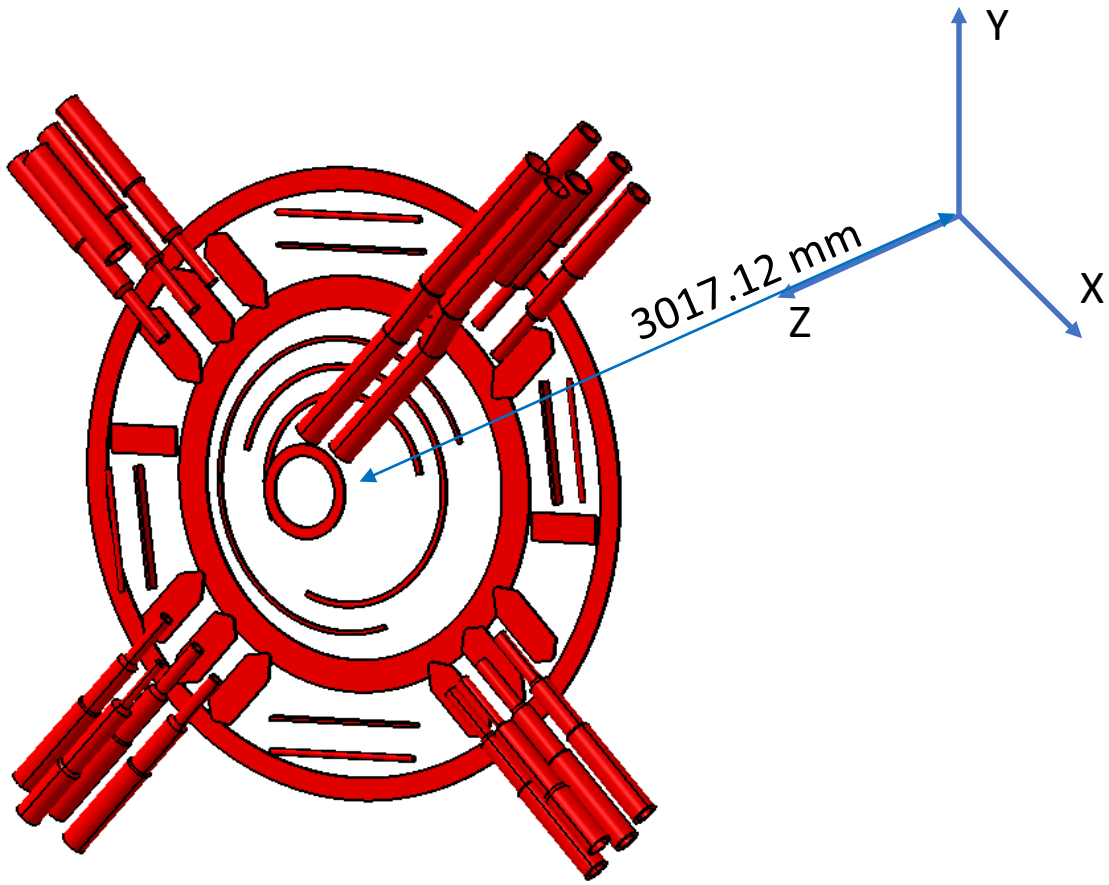
Old Description



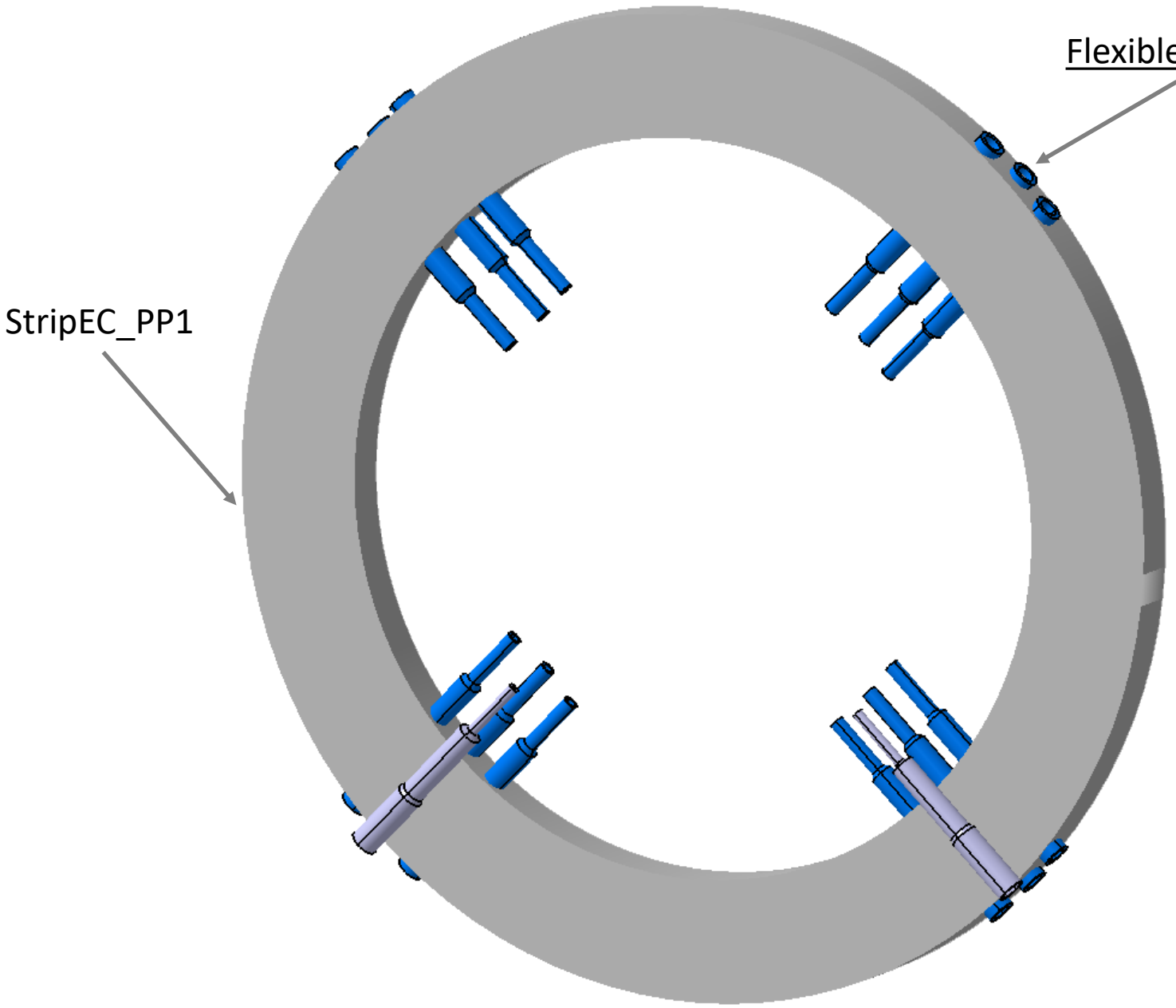
Integration conflicts checking



Cooling Systems are located on the both side (Side A/C)



Conflict between Flexible_Lines and StripEC_PP1



Check Clash

Definition

Name: Interference.1

Type: Contact + Clash | 0mm | Selection: 1 | No selection

Between all components | Selection: 2 | No selection

Results

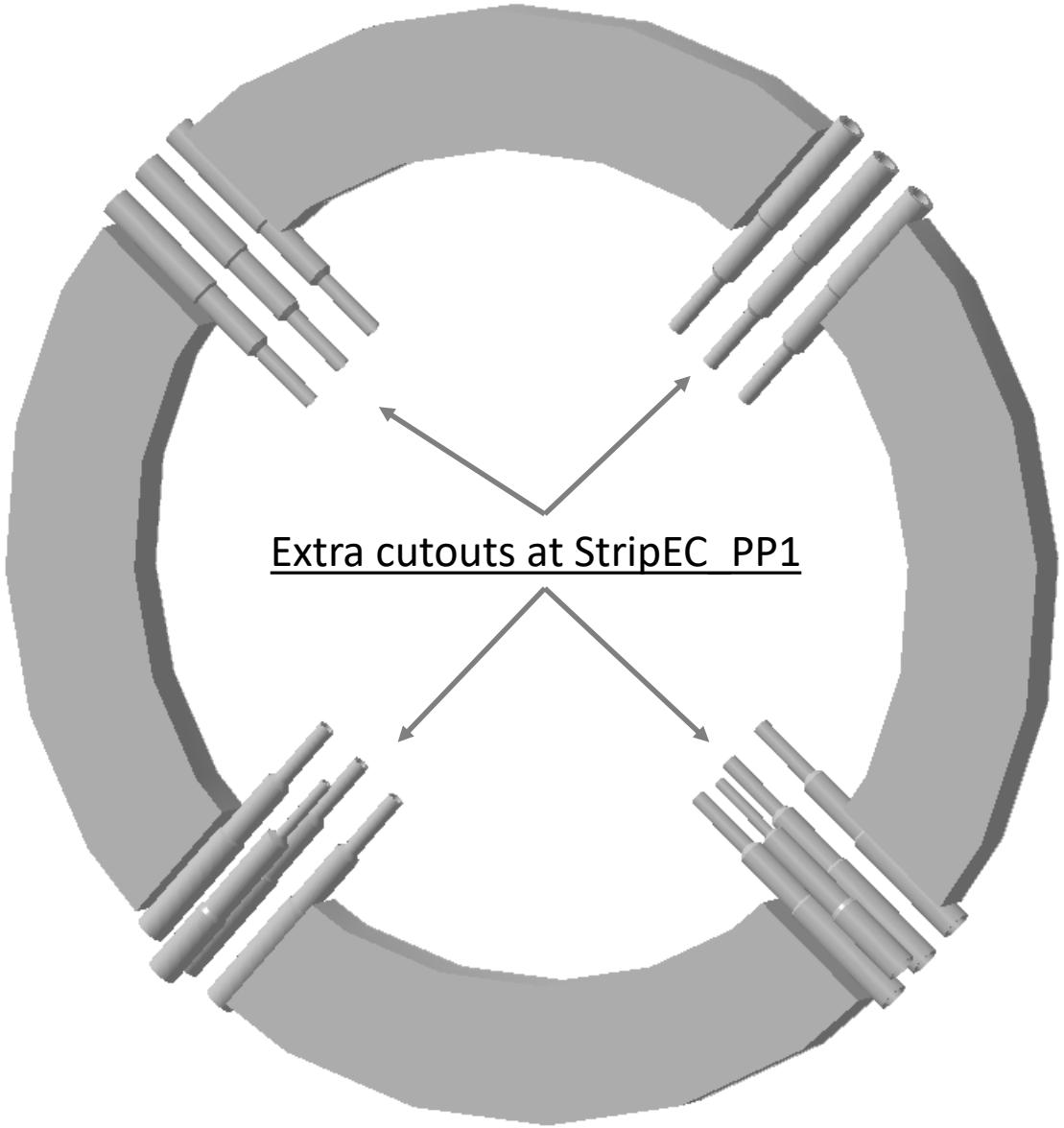
Number of interferences: 12 (Clash:12, Contact:0, Clearance:0)

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

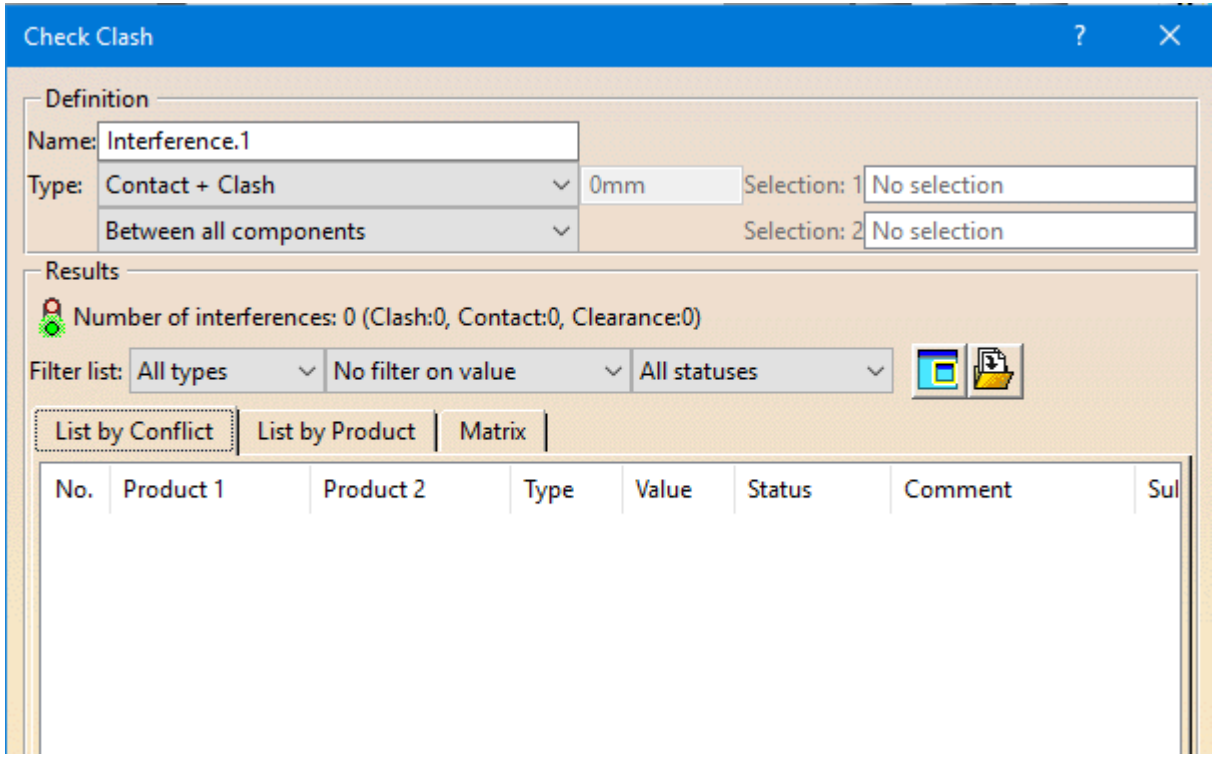
List by Conflict | List by Product | Matrix

No.	Product 1	Product 2	Type	Value	Status	Comment
1	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.65	Relevant	
2	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.93	Relevant	
3	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.64	Relevant	
4	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.65	Irrelevant	
5	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.93	Relevant	
6	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.64	Relevant	
7	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.65	Relevant	
8	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.93	Relevant	
9	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.64	Relevant	
10	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.65	Relevant	
11	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.93	Relevant	
12	Flex_line (Part1...	StripEC_PP1 (S...	Clash	-66.64	Relevant	

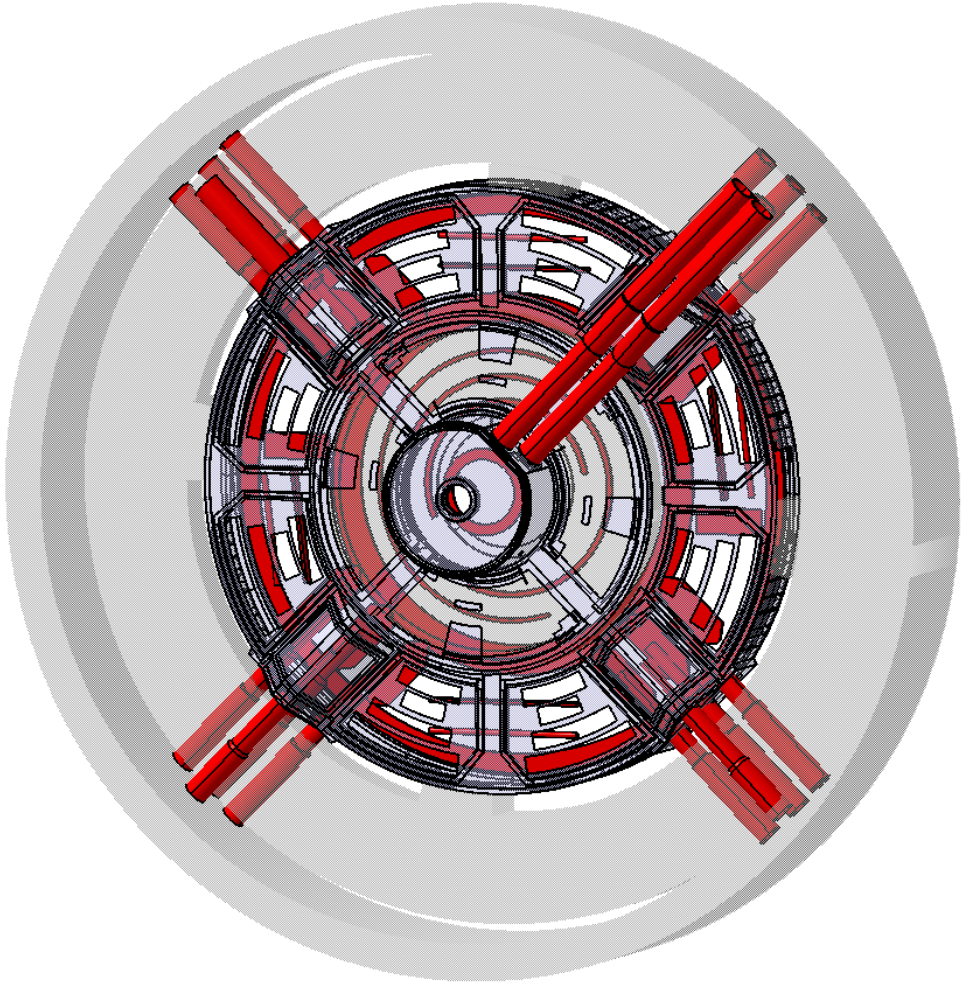
Conflict between Flexible_Lines and StripEC_PP1

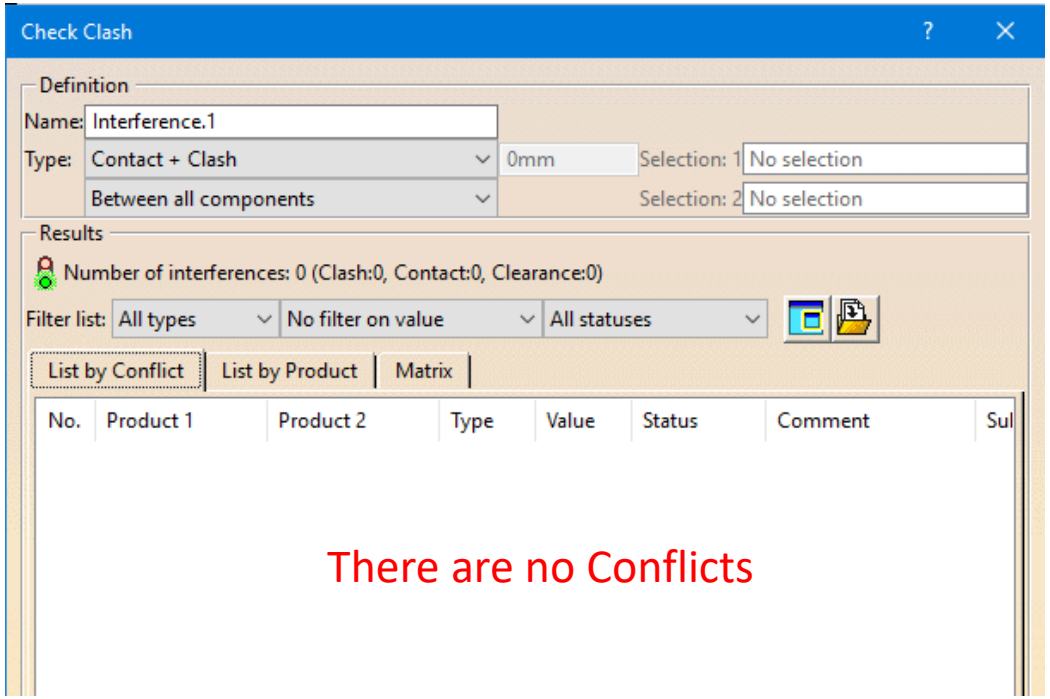


SOLUTION



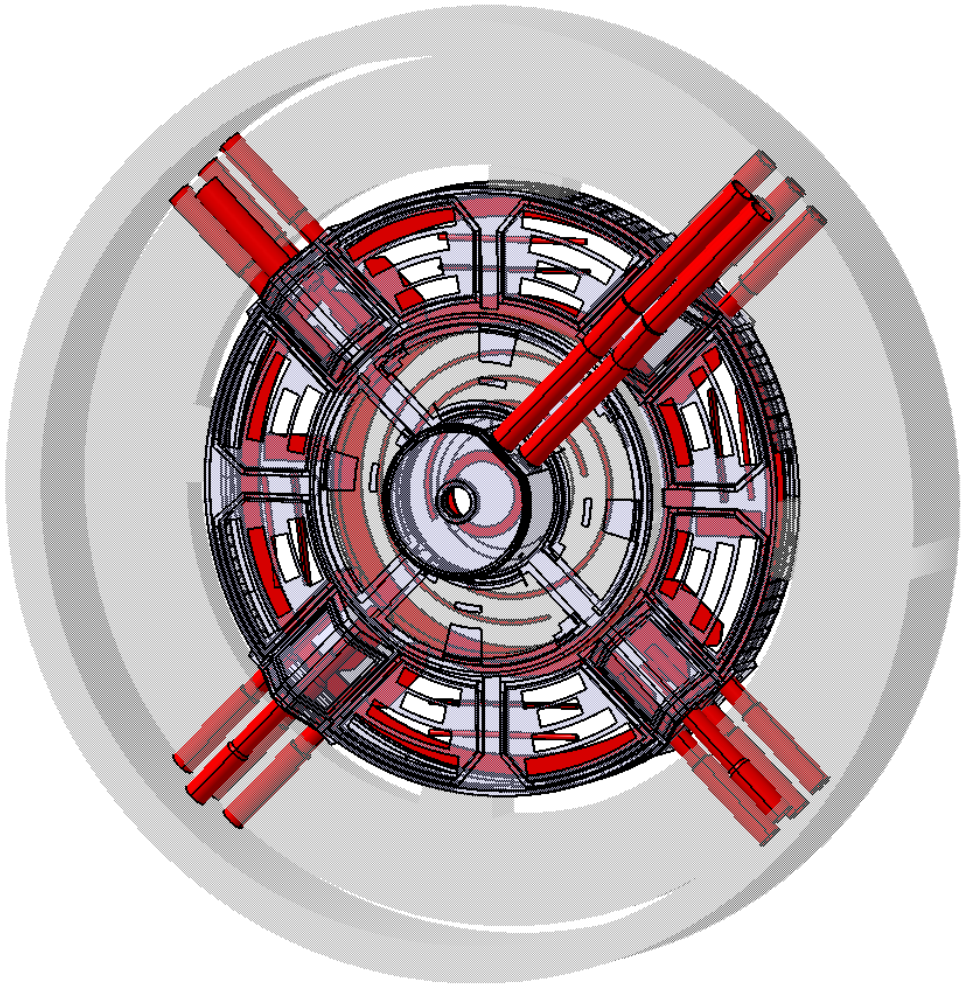
Integration conflicts checking - Using CATIA





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-MyNewDescriptions/ITKLayou...
adding volume ITkPixelDetector to category Envelope with tag ITkPixelDetector
ReadGeoModel::buildGeoModel() done.
First step done. GeoModelTree built from the SQLite file.
*** Real time elapsed    : 2.99892
*** User time elapsed    : 0.96
*** System time elapsed : 0.17
Building G4 geometry.
Second step done. Geant4 geometry created from GeoModeltree
Detector Construction from the plugin file /usr/lib/x86_64-linux-gnu/libGMXPlugin.so, done!
**** Real time elapsed    : 0.555328
**** User time elapsed    : 0.51
**** System time elapsed : 0.01

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


**** Real time elapsed    : 470.439
**** User time elapsed    : 468.87
**** System time elapsed : 0.08

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

==================== Recursive overlap check done! ====================
nika@nika-VirtualBox:~/Packages/ITKLayouts-MyNewDescriptions/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

master / itk_projects / Project N8 - Cooling System / + | Lock | History | Find file | Edit | Code

Upload New File
Niko Tsutskiridze authored 1 minute ago

2c6c92b6

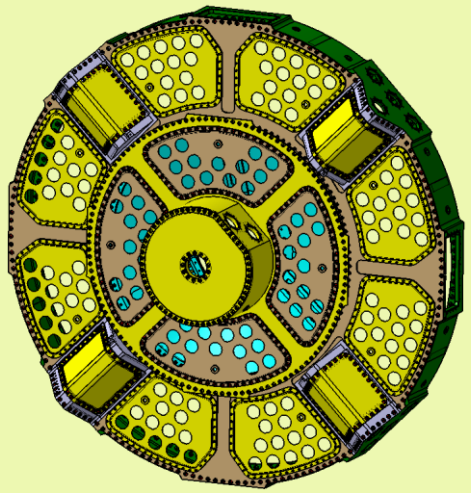
Code owners Assign users and groups as approvers for specific file changes. Learn more. | Manage branch rules

Name	Last commit	Last update
..		
.gitkeep	Add new directory	1 month ago
1._Mass_Analyses.pdf	technical Report of Mass Analyses	1 month ago
2._Compare_Analyses.pdf	Technical Report of Compare Analyses	1 month ago
3._Calculation_of_radiation_length_-_Detailed_vs_GMX.pdf	Technical Report of Radiation Length	1 month ago
4._Simplification.pdf	Technical Report of Simplification	1 month ago
5._Simplification_-_V2.pdf	Upload New File	1 minute ago
6._Integration_Conflicts_Checking.pdf	Upload New File	1 minute ago

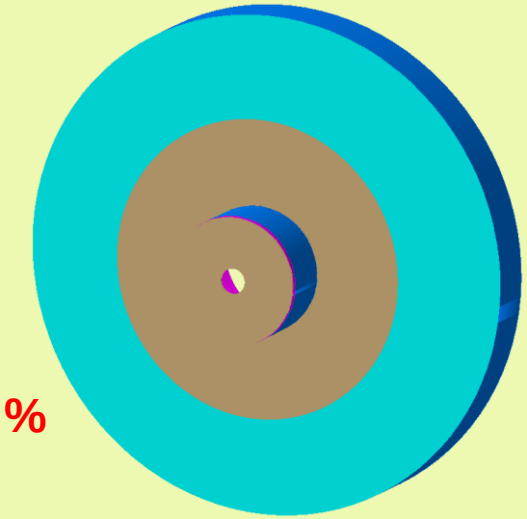
https://gitlab.cern.ch/ntsutski/itk_projects/-/tree/master/Project%20N8%20-%20Cooling%20System

General Status

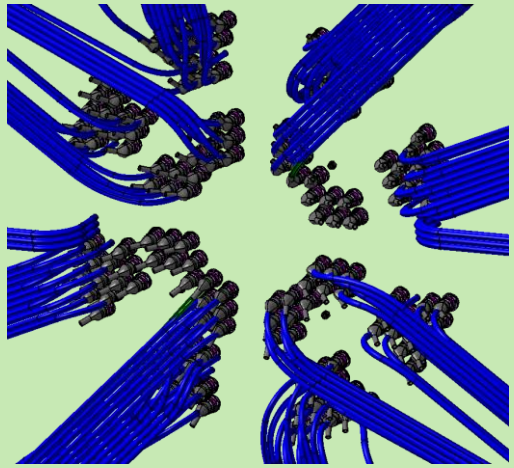
Anticorodal Aluminum Structure



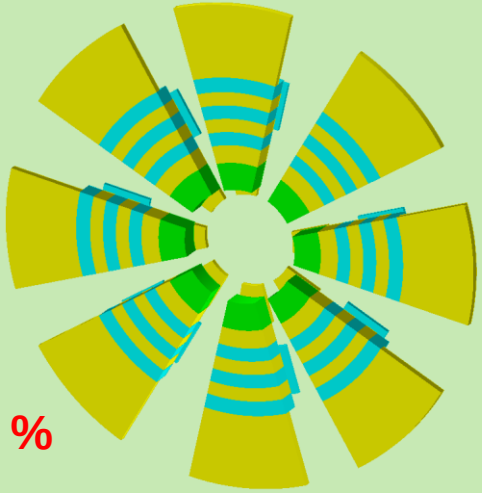
Diff: 51 %



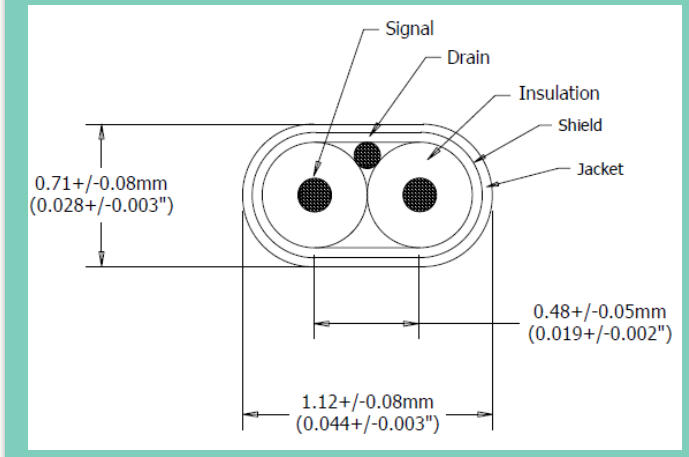
Cables and connectors

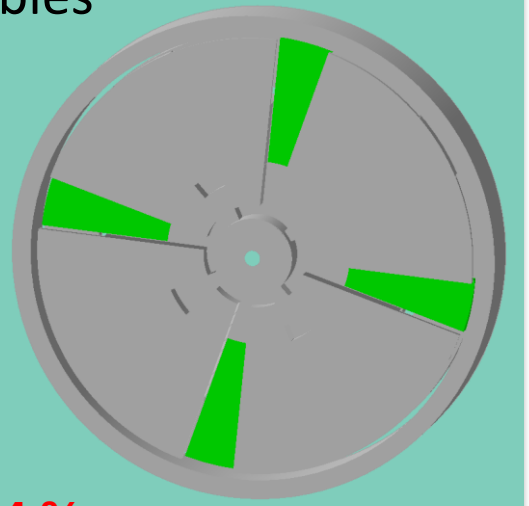


Diff: 43 %



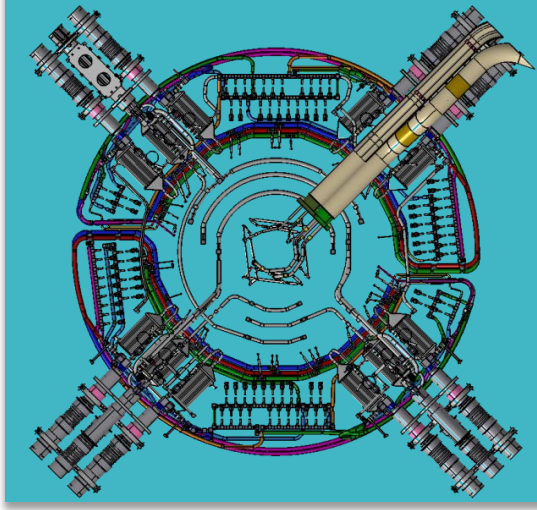
Twin-ax Cables



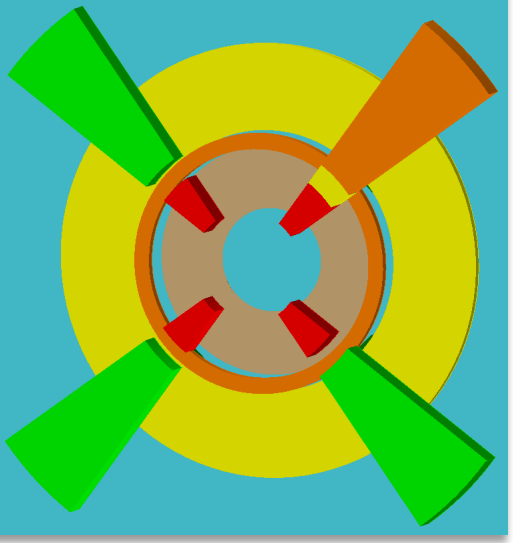


Diff: 64 %

Cooling System



Diff: 55 %
6%



Thank you for your attention

მადლობა ყურადღებისათვის

Niko Tsutskiridze