

# Investigation of New Small Wheel Detector Description

SHARMAZANASHVILI Alexander  
Georgian Technical University

Georgian Nuclear Engineering Center  
Georgian Technical University



# Project Objectives and History

- Current description of NSW using in Simulation is from 2017 Geant4 description: `stations.v2.06.xml`)
- Since there many modifications have been done by the TC group
- Objective of investigation was to compare NSW descriptions of 2017 vs 2019

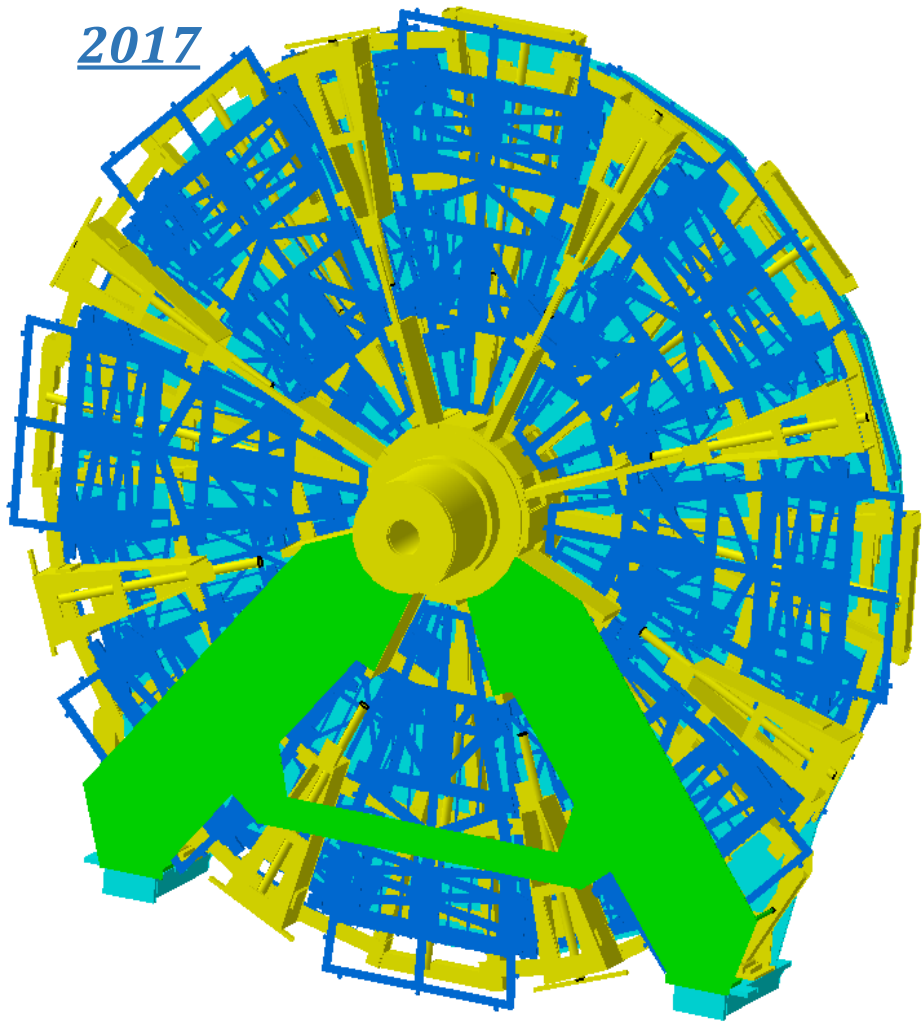
## Project overall parameters:

- Started: 3 May 2019
- Involved rotated manpower: 3 FTE
- Number of Tasks executed: 32
- Working days spent: 112

# Project Objectives and History

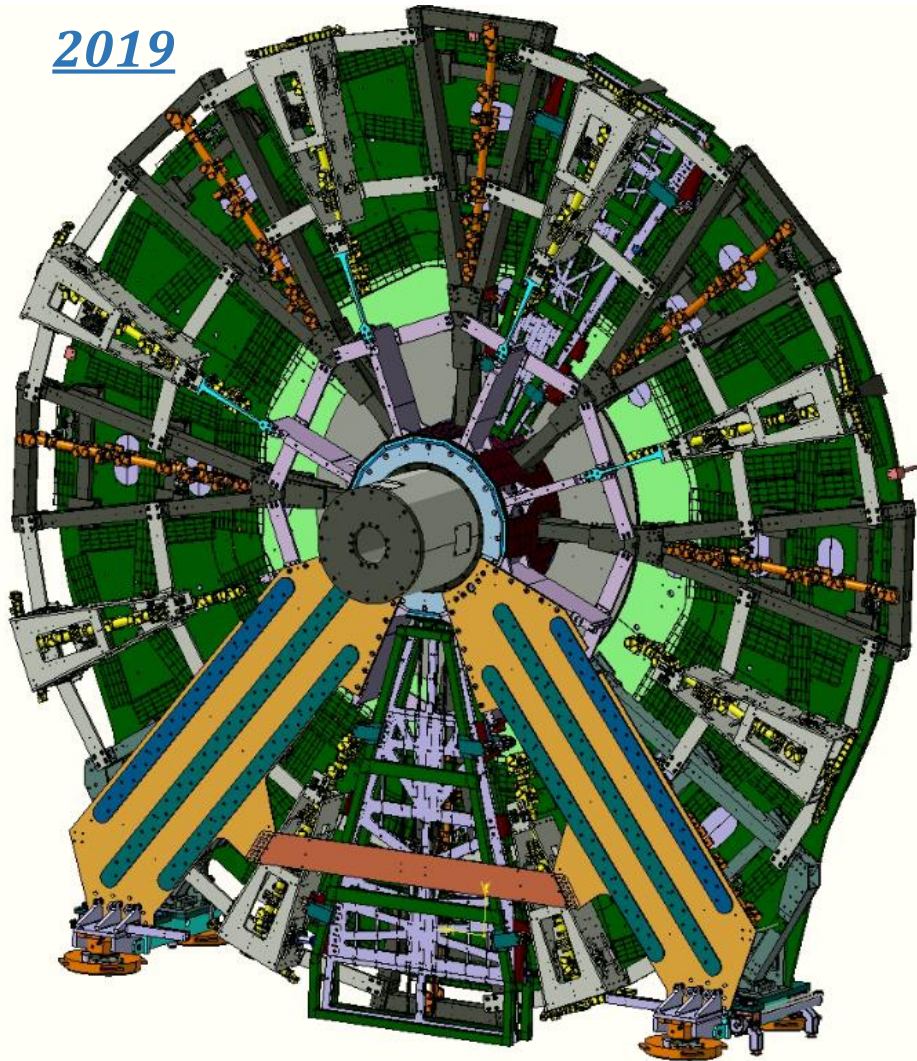
- 2019 description has been taken from TC CATIA DB – 2 prototypes was considered: ST0872036 and ST0912665
- TC designers involved – Tatiana Klutchnikova, Kostantinos Jakovidis, Marco Ciapetti
- Results discussed on Muon Software meetings twice:
  - 21 November 2019 <https://indico.cern.ch/event/858548/>
  - 30 January 2020 <https://indico.cern.ch/event/858558/>

2017



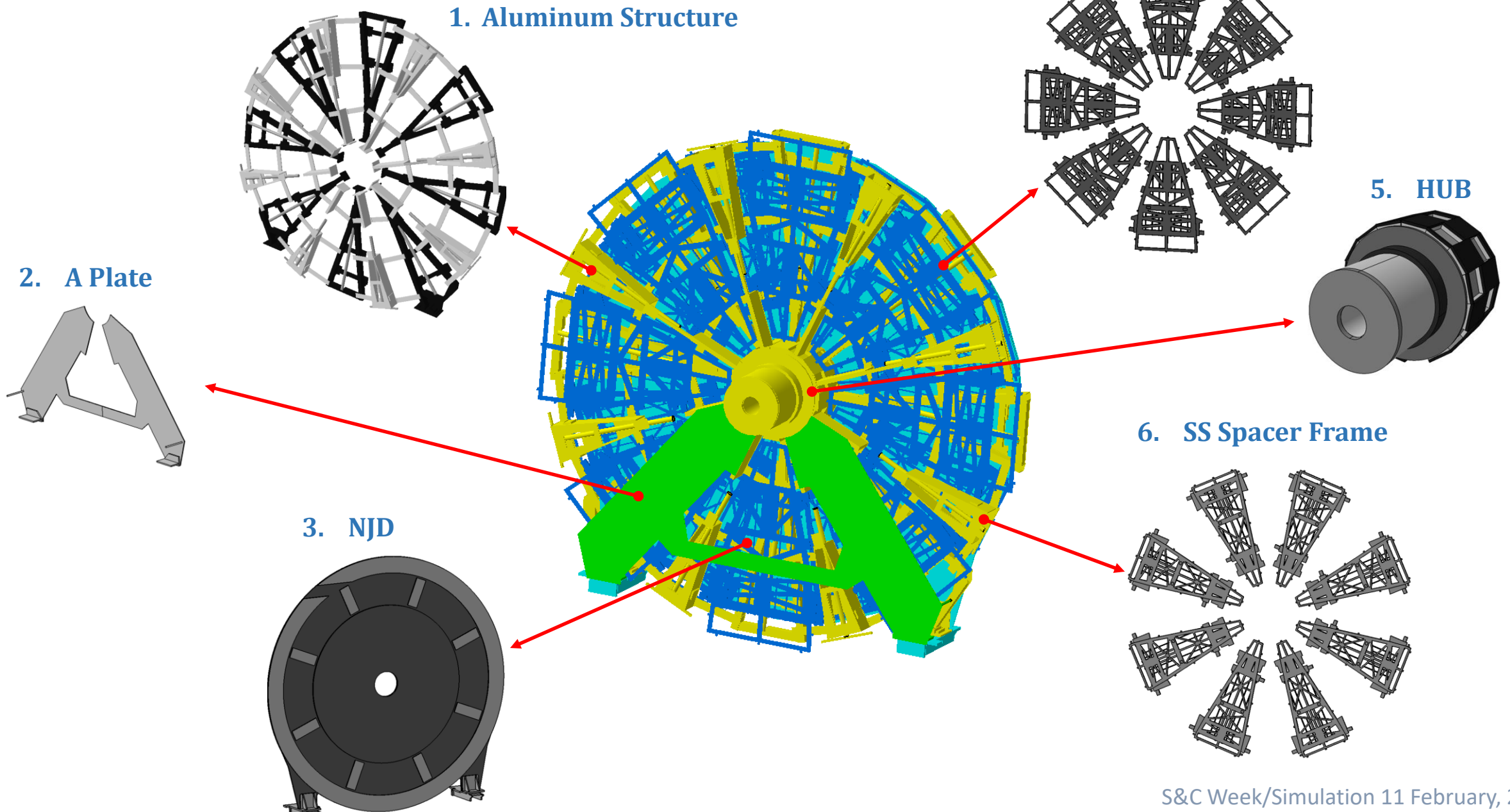
VS

2019



~14 tonnes are missing in 2017 description

# 1<sup>st</sup> STEP: Investigation of Existing Components



# 1<sup>st</sup> STEP: Investigation of Existing Components

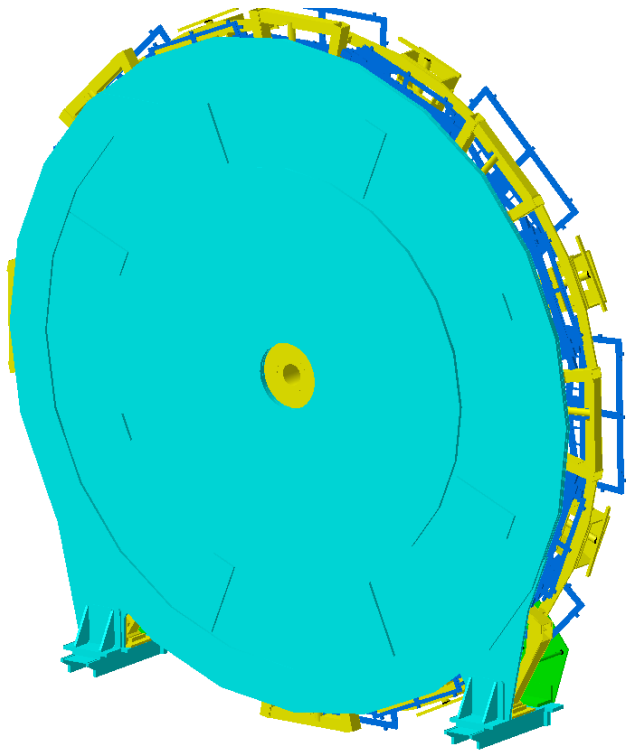
Item	Item Name	2017	2019
		Volume (m <sup>3</sup> ) Weight (kg)	Volume (m <sup>3</sup> ) Weight (kg)
1	Aluminium Structure	Match	Match
2	A Plate	Match	Match
3	NJD	Match	Match
4	LS Spacer Frame	Match	Match
5	HUB	Match	Match
6	SS Spacer Frame	Match	Match



We have proceeded 2 groups of components:

- GROUPE#01: Components with well-defined material
- GROUPE#02: Components with unclear sets of materials

2017



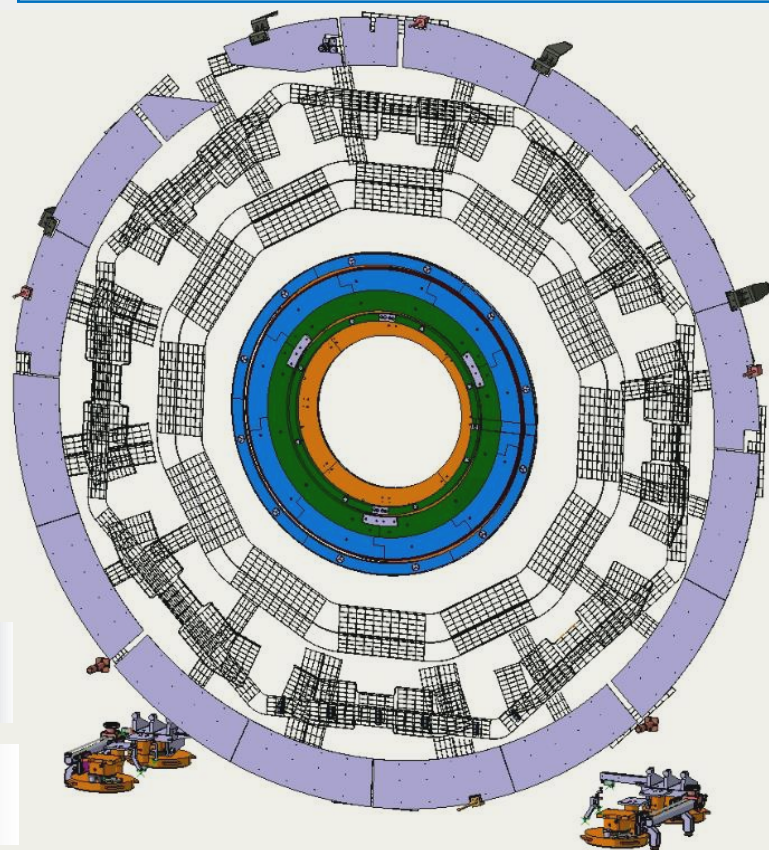
## GROUPE#01 Components:

- 1. Vertical shield HO
- 2. NJD Vert. Shield
- 3. NSW Movant

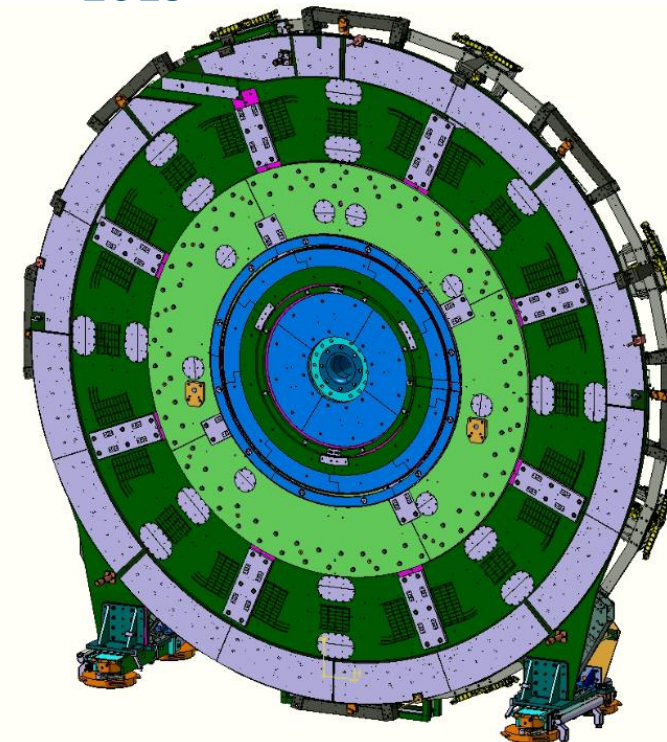
Heavy

- 4. Cable Tray
- 5. Rim Plates
- 6. LS Spoke/Supports/ Rod & Bumpers
- 7. Flexible Chain Brackets

Slight



2019



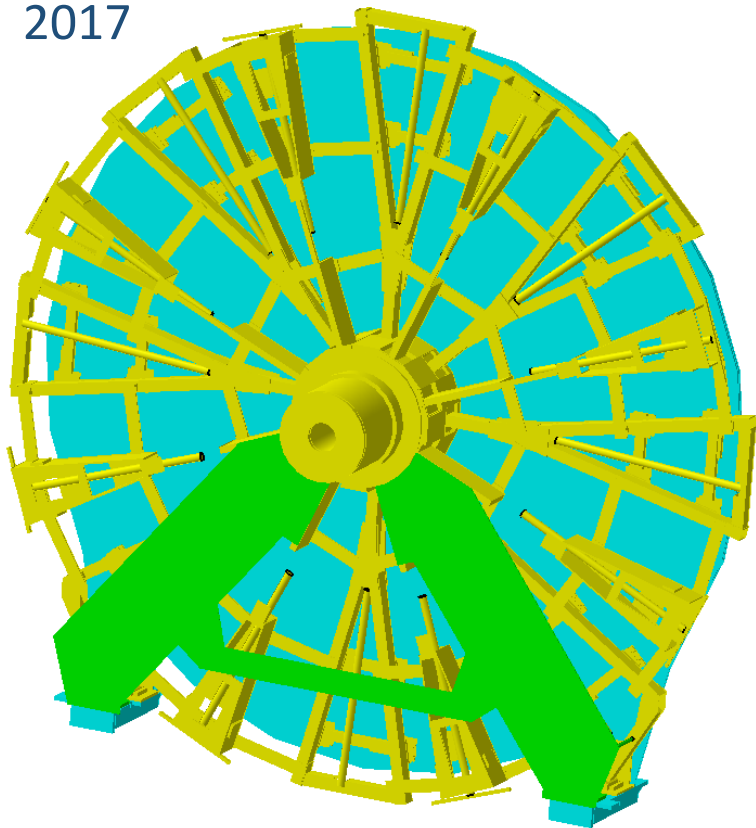
Total:

**1.159 m<sup>3</sup>**  
VOLUME

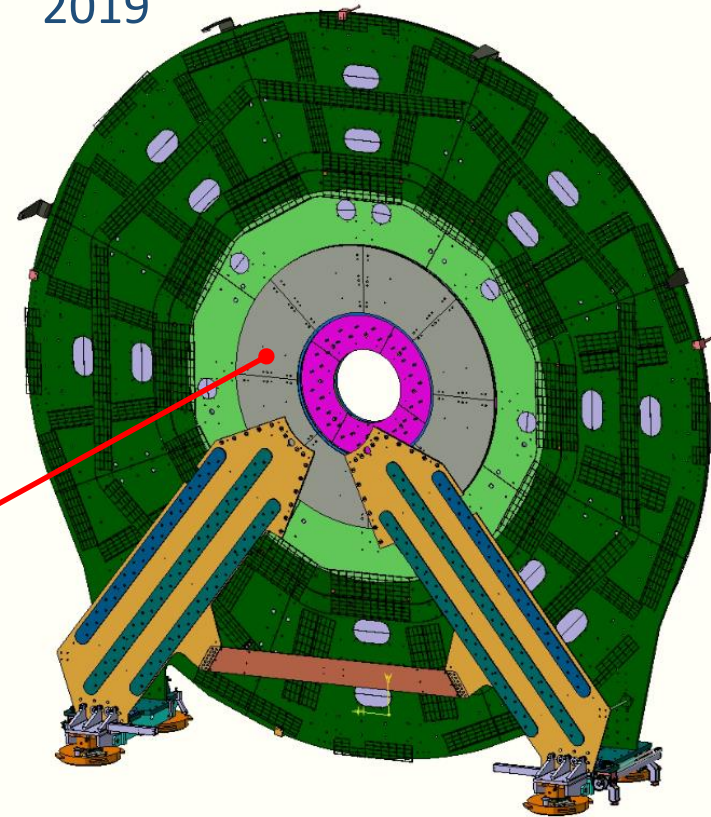
**5833 kg**  
WEIGHT



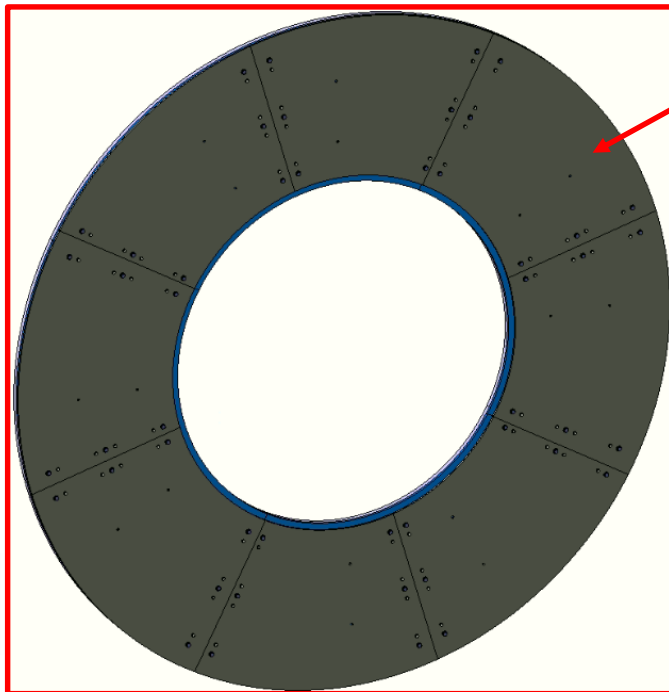
2017



2019



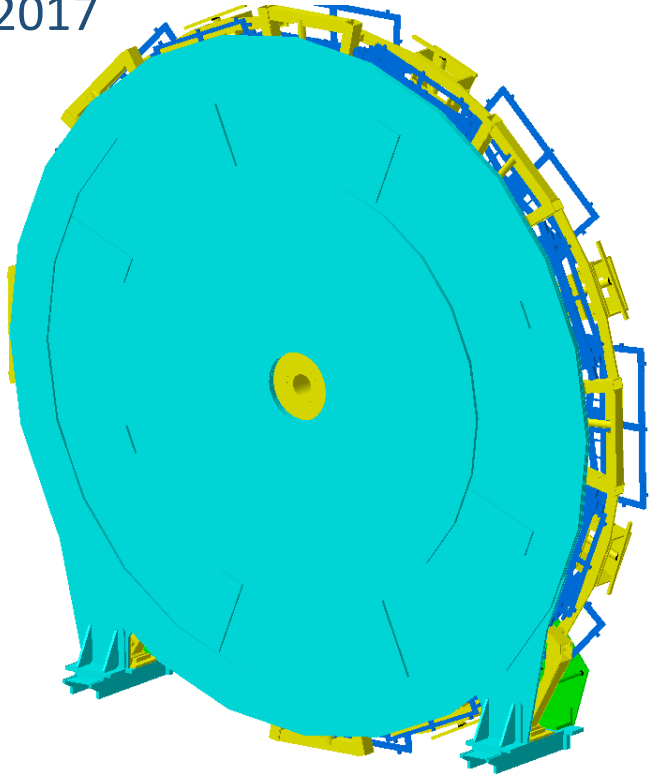
## 1. Vertical Shield HO



**0.317 m<sup>3</sup>**  
VOLUME

**960 kg**  
WEIGHT

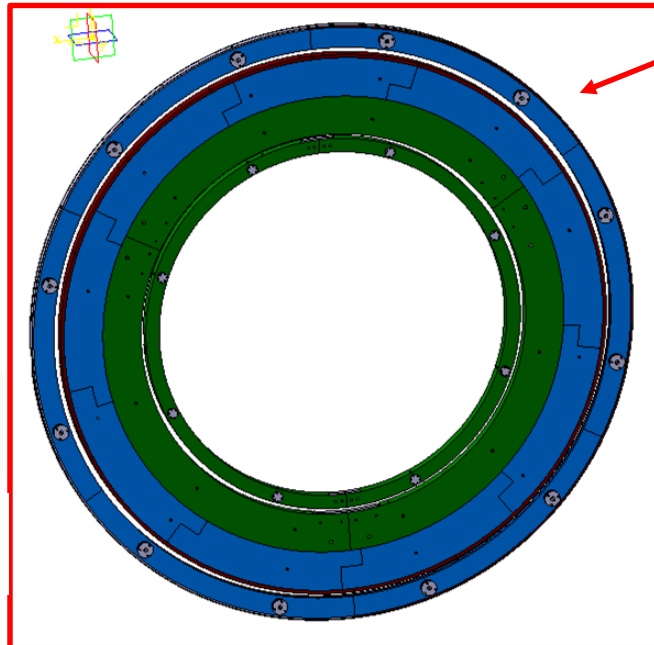
2017



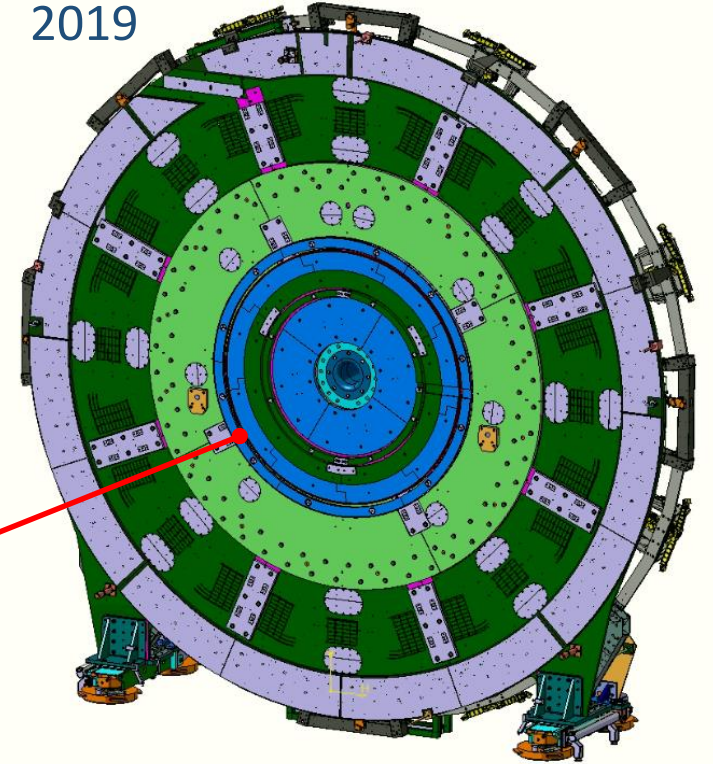
**0.393 m<sup>3</sup>**  
VOLUME

**1733 kg**  
WEIGHT

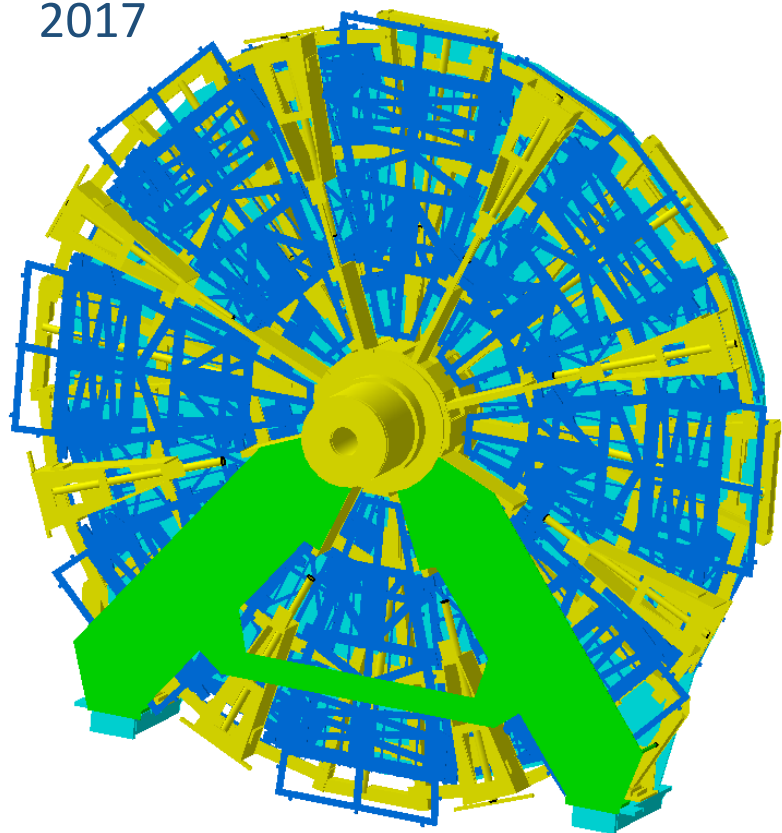
## 2. NJD Vertical Shield



2019



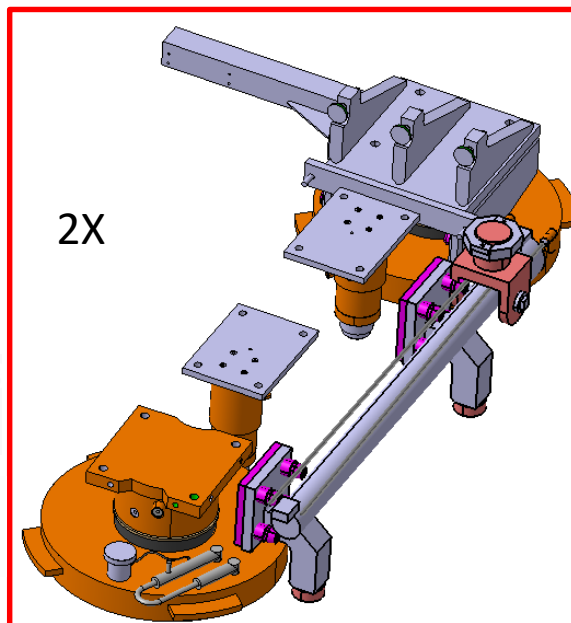
2017



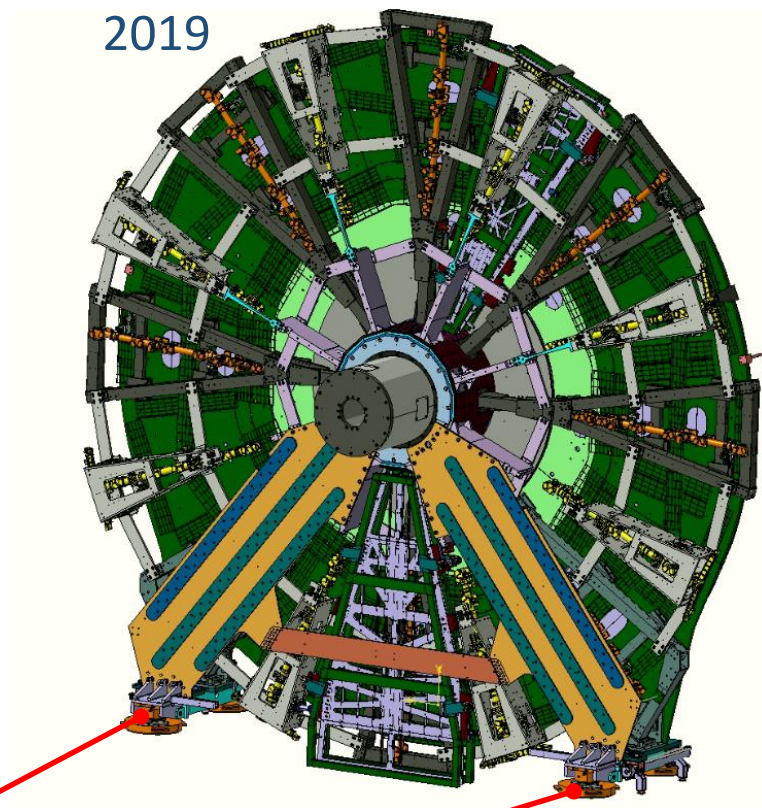
0.3466 m<sup>3</sup>  
VOLUME

2720.8kg  
WEIGHT

## 3. NSW Movement



2019



Summary of Investigation of GROUP#01

	Item	Item Name	2019		Sim	C-Check	XML	Status
			Volume (m <sup>3</sup> )	Weight (kg)				
Heavy	1	Vertical Shield HO	0.317	960	✓	✓	✓	Finished
	2	NJD Vertical Shield	0.393	1'733	✓	✓	✓	Finished
	3	NSW Movement	0.347	2'721	✓	✓	✓	Finished
Slight	4	Cable Tray	0.014	113	✓	✓	✓	Finished
	5	Rim Plates	0.075	13x16	✓	✓	✓	Finished
	6	LS Spoke/Supports/ Rod & Bumpers	0.013	34x3	✓	✓	✓	Finished
	7	Flexible Chain Brackets	0.058	39x4	✗	✗	✗	Waiting Answers



## List of GROUP#02 - Components with unclear sets of materials:

Heavy

1. EIS (sTGC KMs) SS Frame
2. EIL (sTGC KMs) LS Frame
3. LV crate concept
4. Main Pipes
5. Brackets
6. Alignment Boxes

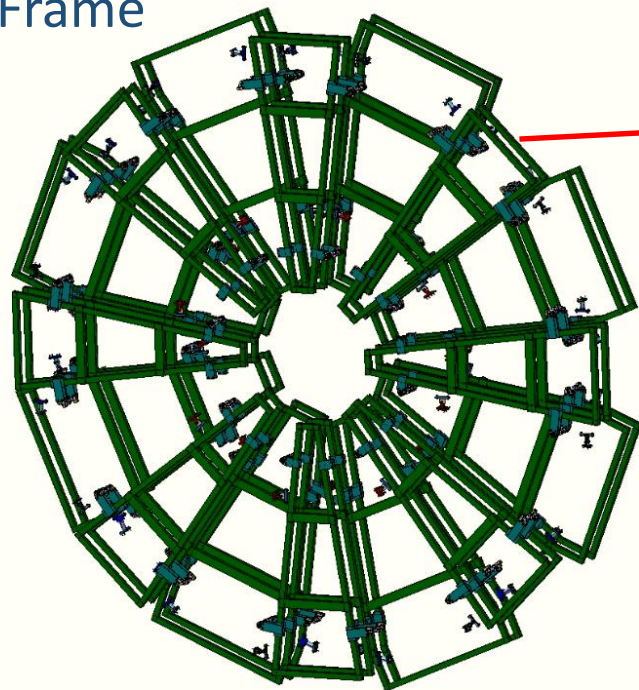
Slight

7. Gas Manifolds
8. Sec Pipes
9. Rim Crate
10. Lower BrackerG Pipes
11. Routing Hydraulic Pipes
12. protec\_V2
13. THREE STAR MTP-12LC MODULES IN SMALL BOX
14. HV\_MM\_SPLITTER
15. Alignment Boxes Support
16. Cable tray on IP side\_V2

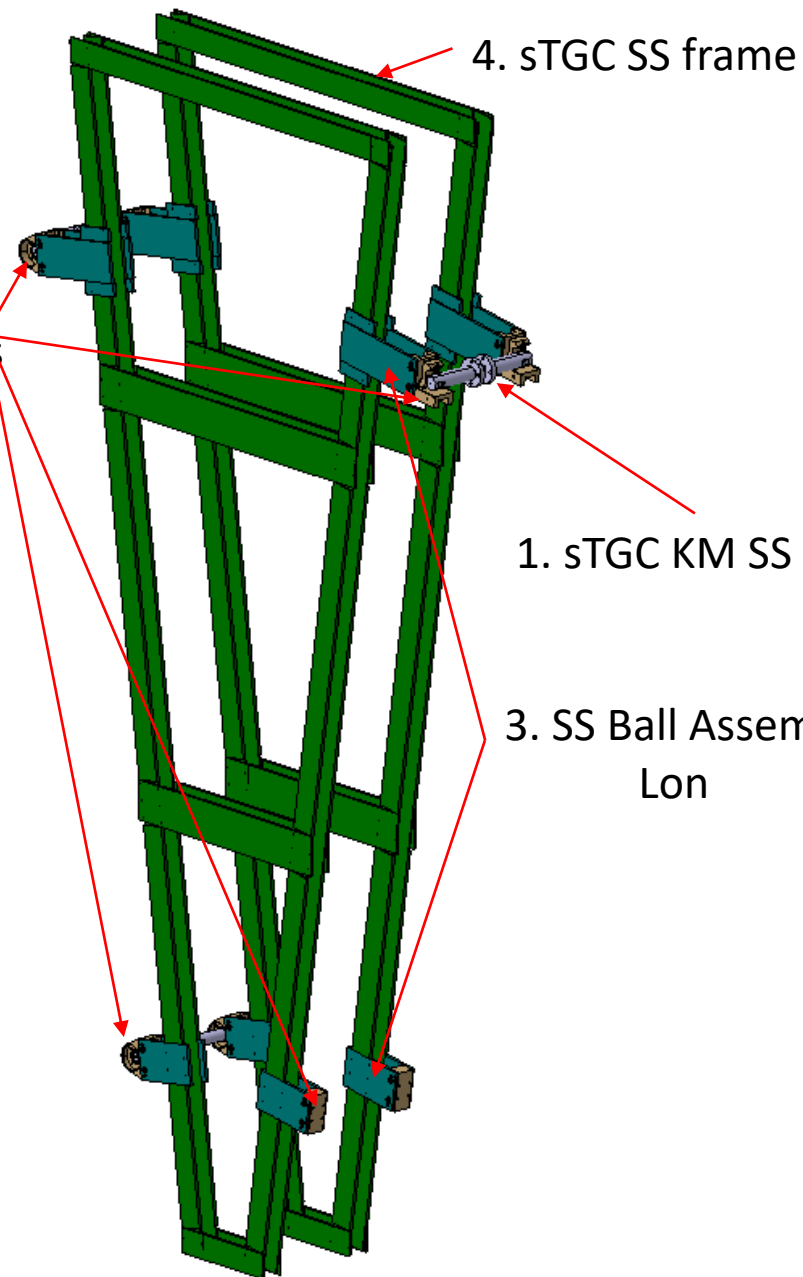


# 3<sup>rd</sup> STEP: Consideration of GROUPE#02

## 1. EIS (sTGC KMs) SS Frame



2. sTGC SS interfaces



4. sTGC SS frame

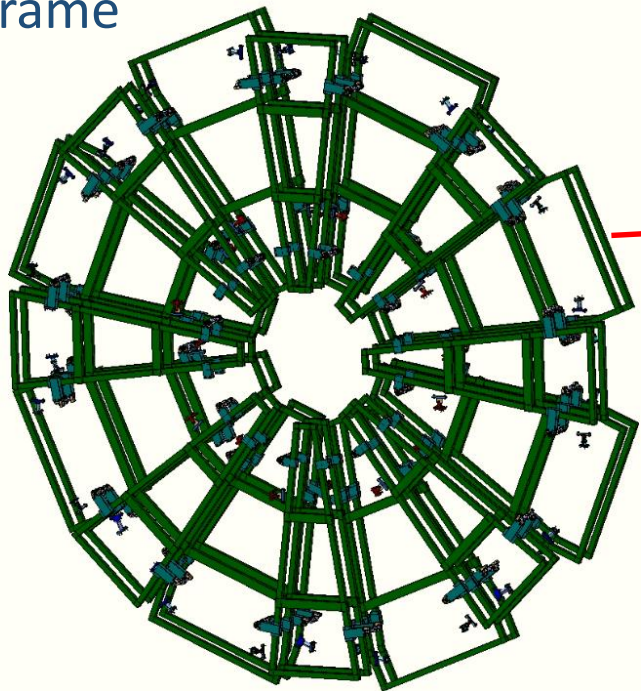
1. sTGC KM SS fixed

3. SS Ball Assembly  
Lon

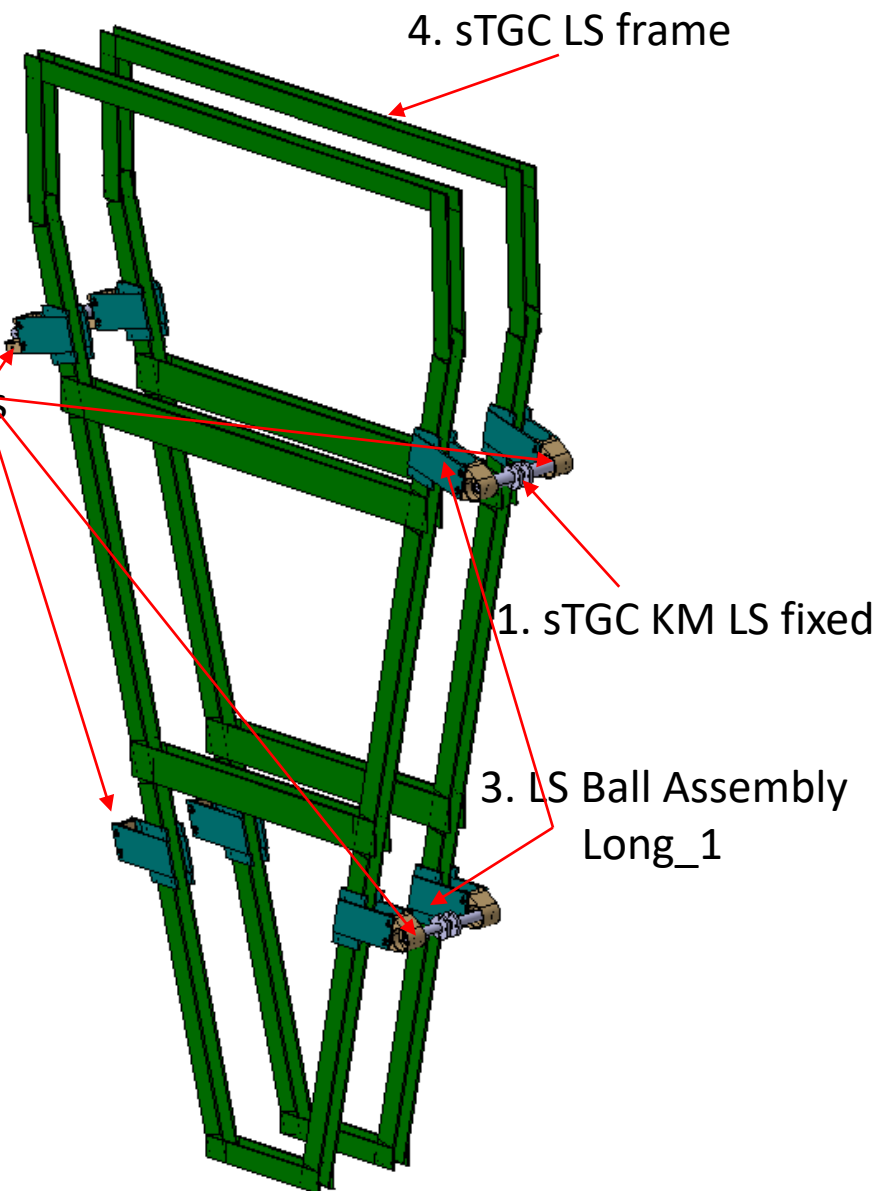
name	Material	Density (kg/m <sup>3</sup> )	Volume (m <sup>3</sup> )	Weight (kg)
1. sTGC KM SS fixed	Stainless Steel	8000	0.00164	13.1
2. sTGC SS interfaces	Stainless Steel	8000	0.00333	26.6
3. SS Ball Assembly Long_1	Fiber grass FR4	1850	0.00512	9.5
4. sTGC SS frame	Fiber grass FR4	1850	0.03218	59.5
		Tot(per):	0.0423	108.7
		Total(8x):	0.3382	870

# 3<sup>rd</sup> STEP: Consideration of GROUPE#02

## 2. EIL (sTGC KMs) LS Frame



2. sTGC LS interfaces

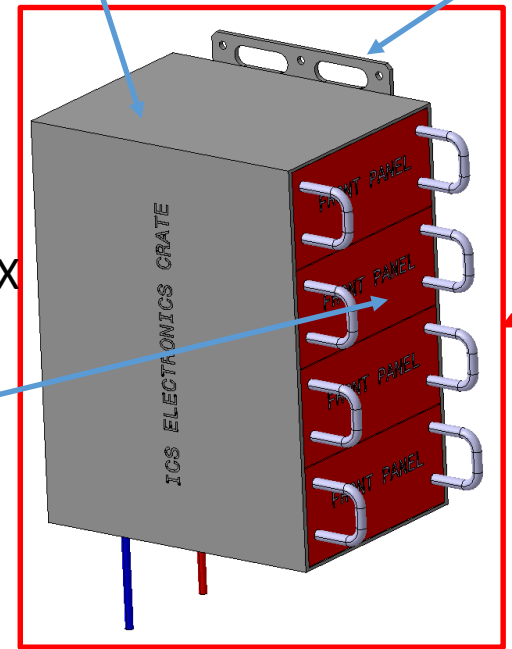


name	Material	Density (kg/m <sup>3</sup> )	Volume (m <sup>3</sup> )	Weight (kg)
1. sTGC KM LS fixed	Stainless Steel	8000	0.001657	13.3
2. sTGC LS interfaces	Stainless Steel	8000	0.00333	26.6
3. LS Ball Assembly Long_1	Fiber grass FR4	1850	0.006076	11.2
4. sTGC LS frame	Fiber grass FR4	1850	0.042068	77.8
Tot(per):			0.0531	128.9
Total(8x):			0.425	1'031

# 3<sup>rd</sup> STEP: Consideration of GROUPE#02

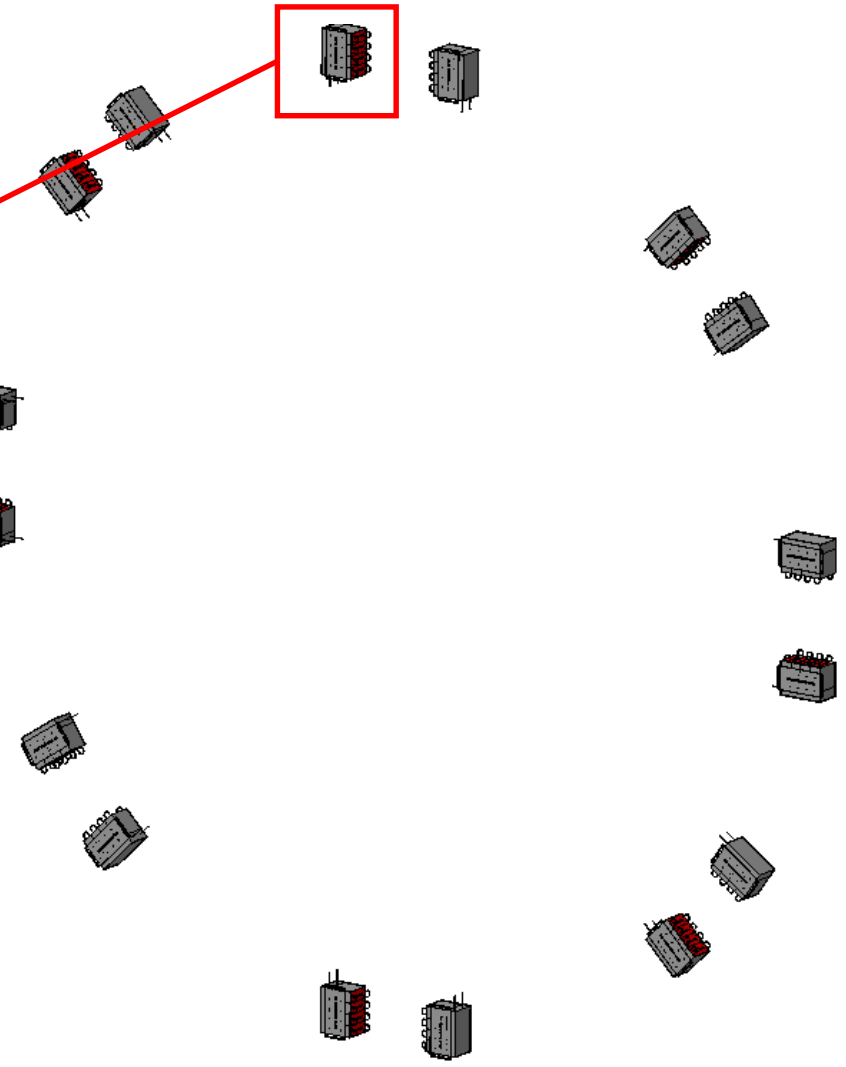
## 3. LV crate concept

- 1. ICS LV Crate
- 2. ICS\_Fixing\_plate



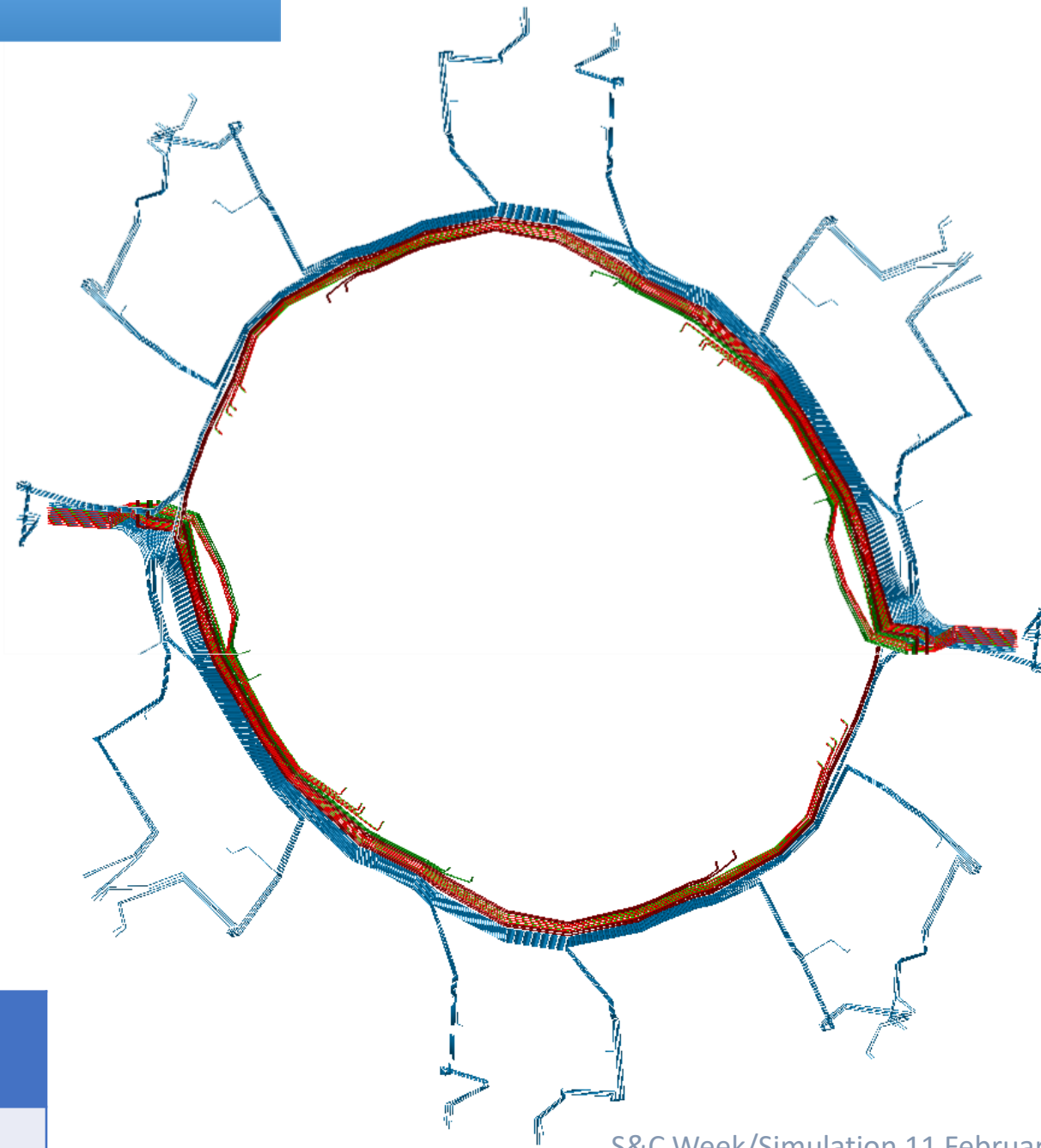
16X

3. V2\_Electronic card\_w/cooling



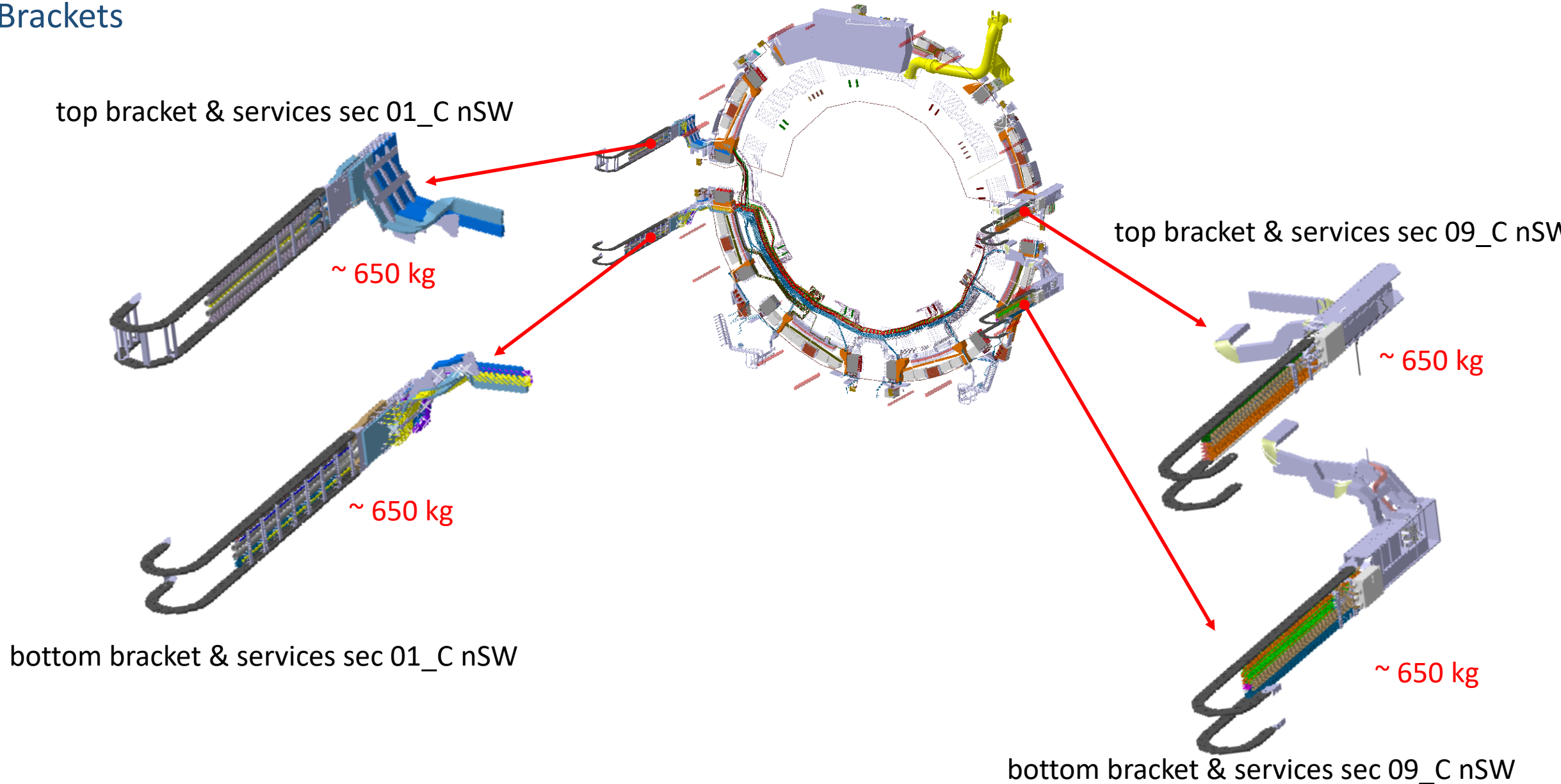
name	Material	Density (kg/m <sup>3</sup> )	Volume (m <sup>3</sup> )	Weight (kg)
1. ICS LV Crate	Aluminum	2660	0.0023	6.1
2. ICS_Fixing_plate	EN AW-5080			
3. V2_Electronic card_w/cooling and Electrical Parts (Electrical Parts must be located on Electrical Plates)	Grass-epoxy/other	1800/other	0.0162/other	58.3
		Total:	0.0185	64.4
		Total(16x):	0.296	1'030.4

## 4. Main Pipes



name	Material	Density (kg/m <sup>3</sup> )	Volume (m <sup>3</sup> )	Weight (kg)
Main Pipes	Copper	8960	0.0204	182.8

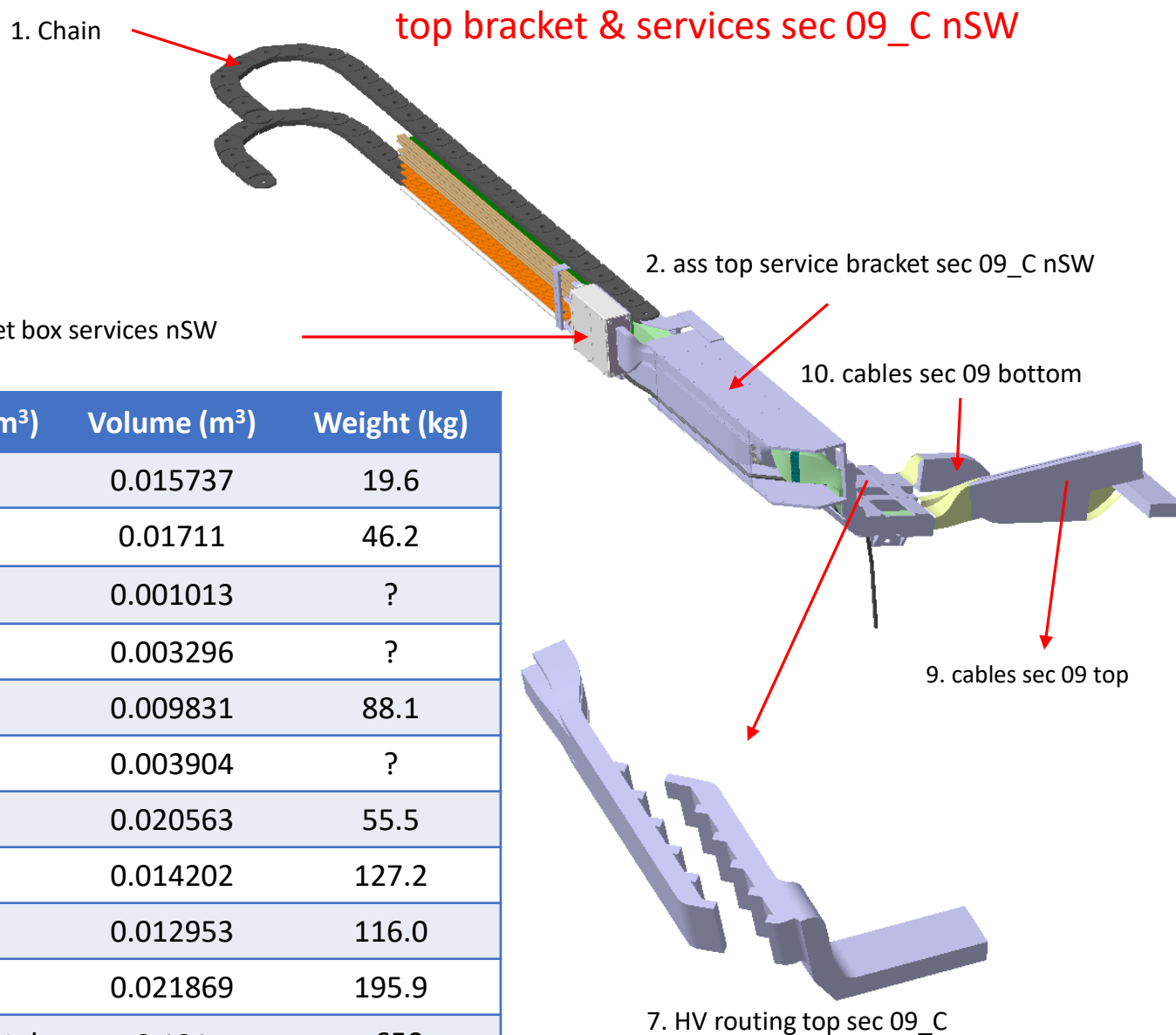
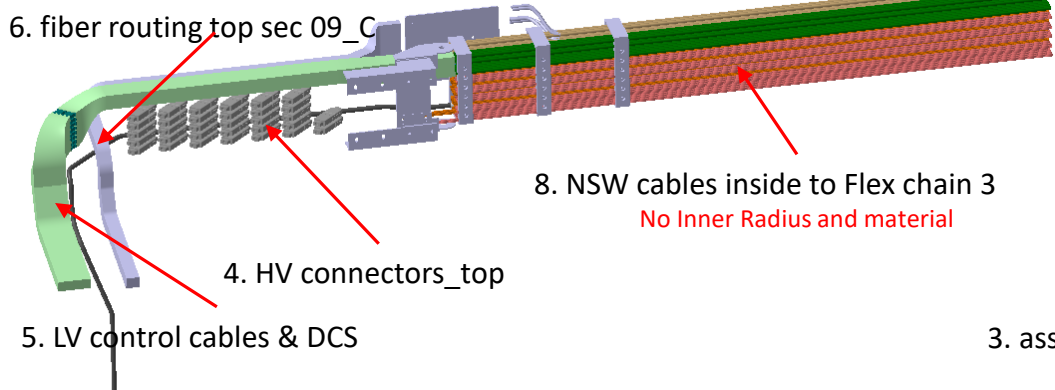
## 5. Brackets





# 3<sup>rd</sup> STEP: Consideration of GROUPE#02

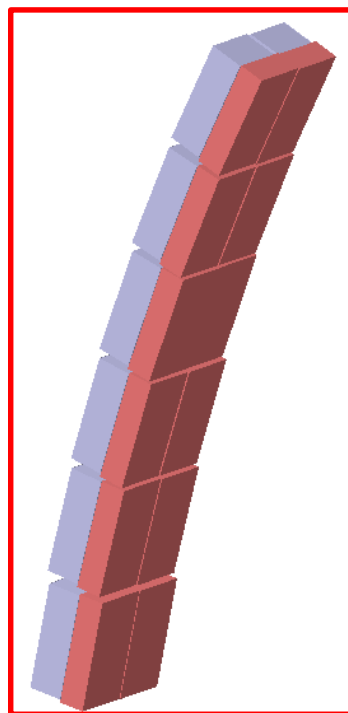
## 5. Brackets



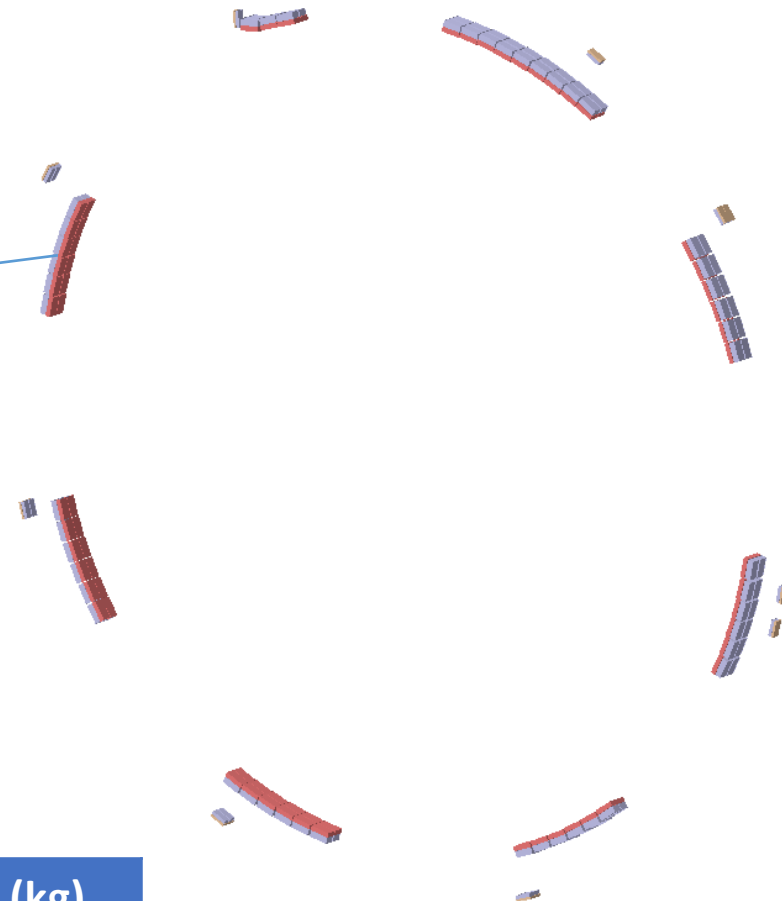
name	Material	Density (kg/m <sup>3</sup> )	Volume (m <sup>3</sup> )	Weight (kg)
1. Chain	Plastic	~1245	0.015737	19.6
2. ass top service bracket sec 09_C nSW	Aluminum	2700	0.01711	46.2
3. ass fibernet box services nSW	?	?	0.001013	?
4. HV connectors_top	?	?	0.003296	?
5. LV control cables & DCS	Copper	8960	0.009831	88.1
6. fiber routing top sec 09_C	?	?	0.003904	?
7. HV routing top sec 09_C	Aluminum	2700	0.020563	55.5
8. NSW cables inside to Flex chain 3	Copper	8960	0.014202	127.2
9. 03_1 cables sec 09 top	Copper	8960	0.012953	116.0
10. 04_1 cables sec 09 bottom	Copper	8960	0.021869	195.9
		Total:	0.121	-650
		Total(4x):	0.48	2'600

# 3<sup>rd</sup> STEP: Consideration of GROUPE#02

## 6. Alignment Boxes



Envelope Only



name	Material	Density (kg/m <sup>3</sup> )	Volume (m <sup>3</sup> )	Weight (kg)
Alignment Boxes	Stainless Steel *	8000	0.0252	201.5
	Total:		0.2	1'600

\* Material have to be checked with Technical Coordination Team

Summary of Investigation of GROUP#02

	Item	Item Name	2019		Sim	C-Check	XML	Status
			Volume (m <sup>3</sup> )	Weight (kg)				
Heavy	1	EIS (sTGC KMs) SS Frame	0.3382	870	✓	✓	✓	Finished
	2	EIL (sTGC KMs) LS Frame	0.425	1'031	✓	✓	✓	Finished
	3	LV crate concept	0.296	1'030	✓	✓	✓	Finished
	4	Main Pipes	0.0204	182	✗	✗	✗	Waiting Answers
	5	Brackets	0.482	2'600	✗	✗	✗	Waiting Answers
	6	Alignment Boxes	0.2	1'600	✗	✗	✗	Waiting Answers
Slight	7	Gas Manifolds	0.0062	16	✗	✗	✗	Waiting Answers
	8	Sec Pipes	0.0083	74	✗	✗	✗	Waiting Answers
	9	Rim Crate	0.05	16x16	✗	✗	✗	Waiting Answers
	10	Lower BrackerG Pipes	0.0027	25	✗	✗	✗	Waiting Answers
	11	Routing Hydraulic Pipes	0.014	70	✗	✗	✗	Waiting Answers
	12	protec_V2	0.006	49	✗	✗	✗	Waiting Answers
	13	THREE STAR MTP-12LC MODULE	0.042	4x87	✗	✗	✗	Waiting Answers
	14	HV_MM_SPLITTER	0.014	45	✗	✗	✗	Waiting Answers
	15	Alignment Boxes Support	0.006	14	✗	✗	✗	Waiting Answers
	16	Cable tray on IP side_V2	0.004	31	✗	✗	✗	Waiting Answers

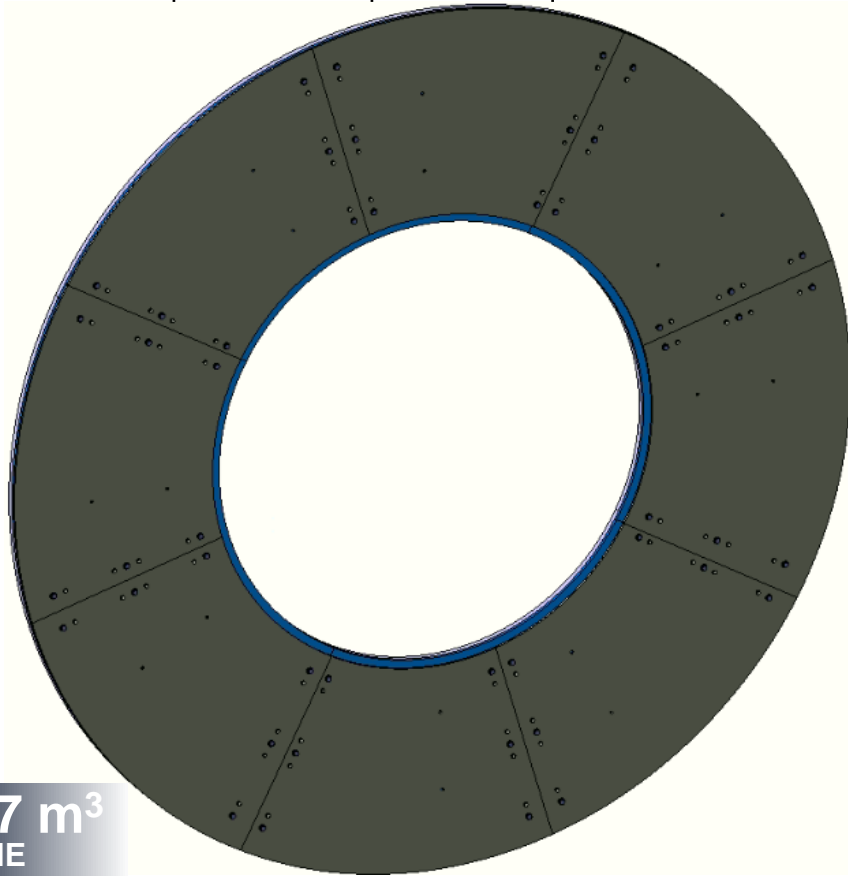
Following 'Heavy' Components have been simplified:

1. Vertical shield HO
2. NJD Vertical shield
3. NSW Movement
4. Cable Tray
5. EIS (sTGC KMs) SS Frame
6. EIL (sTGC KMs) SS Frame

# 4<sup>th</sup> STEP: Simplification / Vertical shield H0

Material	Density	Volume (m <sup>3</sup> )	Weight (kg)
HD PE Borotron® 5% HD050	1010	0.255	257.6
Lead	11340	0.062	703
<b>Total:</b>			<b>960.6</b>

Detailed

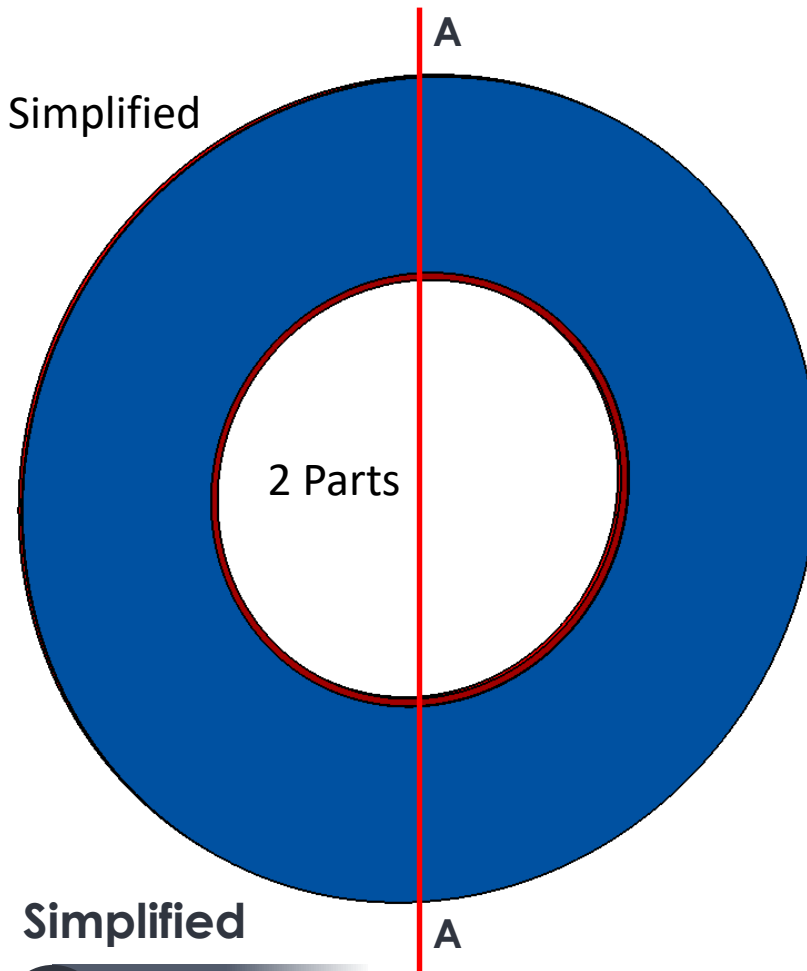


Detailed

**0.317 m<sup>3</sup>**  
VOLUME

**960 kg**  
WEIGHT

Simplified

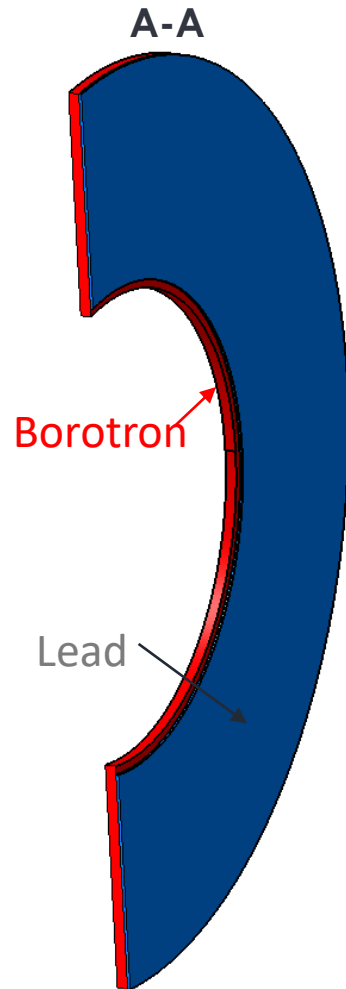


Simplified

**0.317 m<sup>3</sup>**  
VOLUME

**960 kg**  
WEIGHT

Diff. 0kg

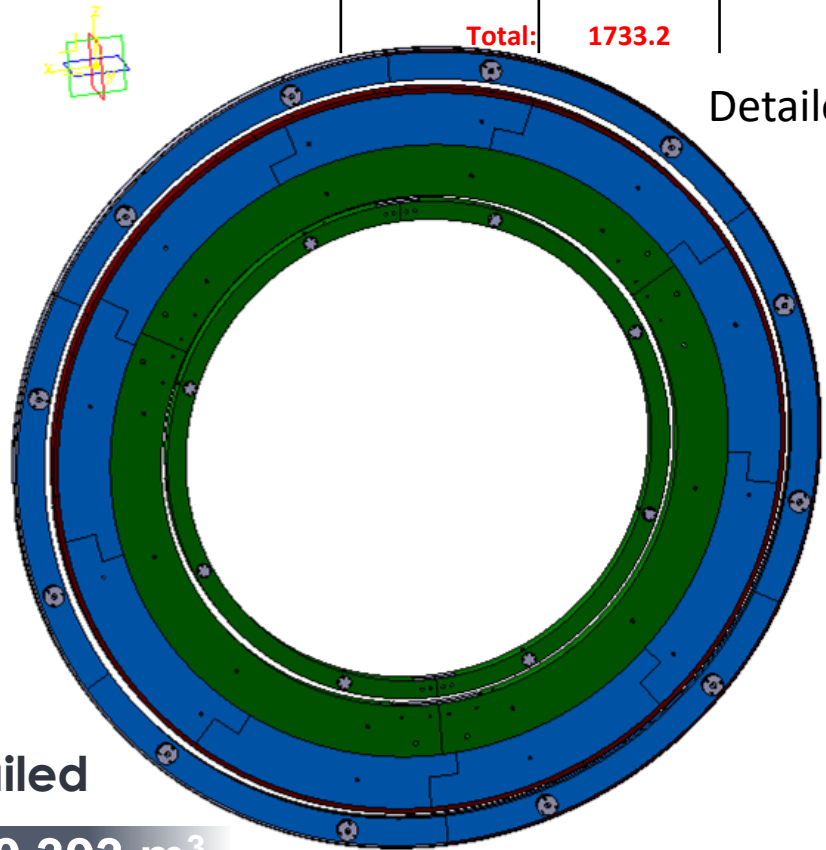




# 4<sup>th</sup> STEP: Simplification / NJD Vertical Shield

Material	Density	Volume (m <sup>3</sup> )	Weight (kg)
HD PE Borotron® 5% HD050	1010	0.21	212.1
SSteel	8000	0.1625	1300
Lead	11340	0.0195	221.13

Total: 1733.2

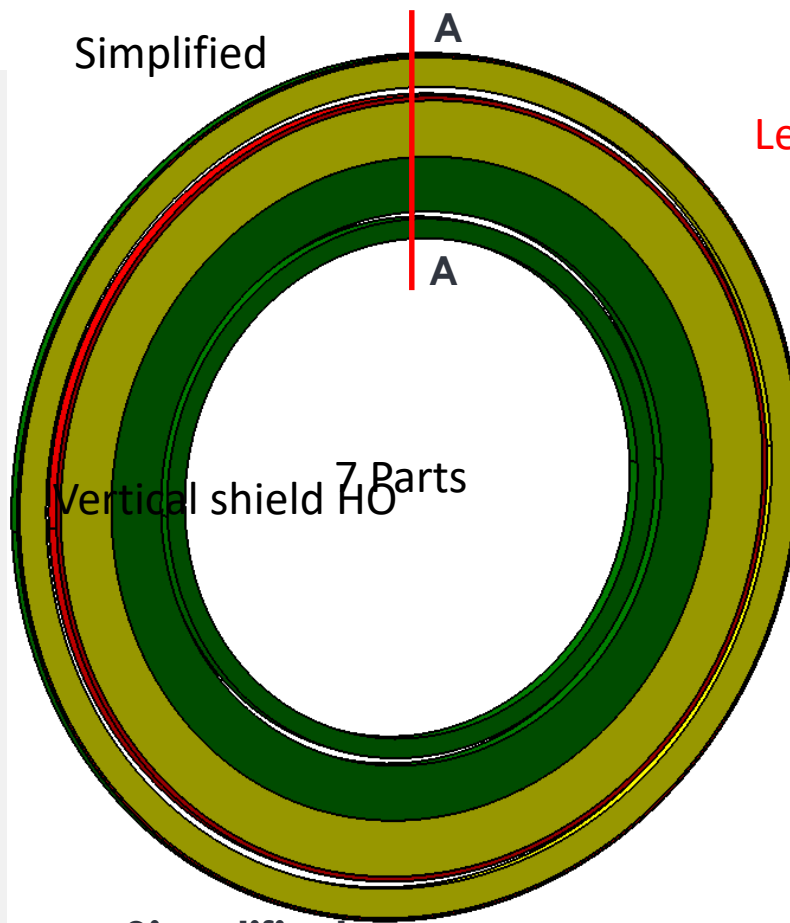


Detailed

Detailed

0.393 m<sup>3</sup>  
VOLUME

1733 kg  
WEIGHT



Simplified

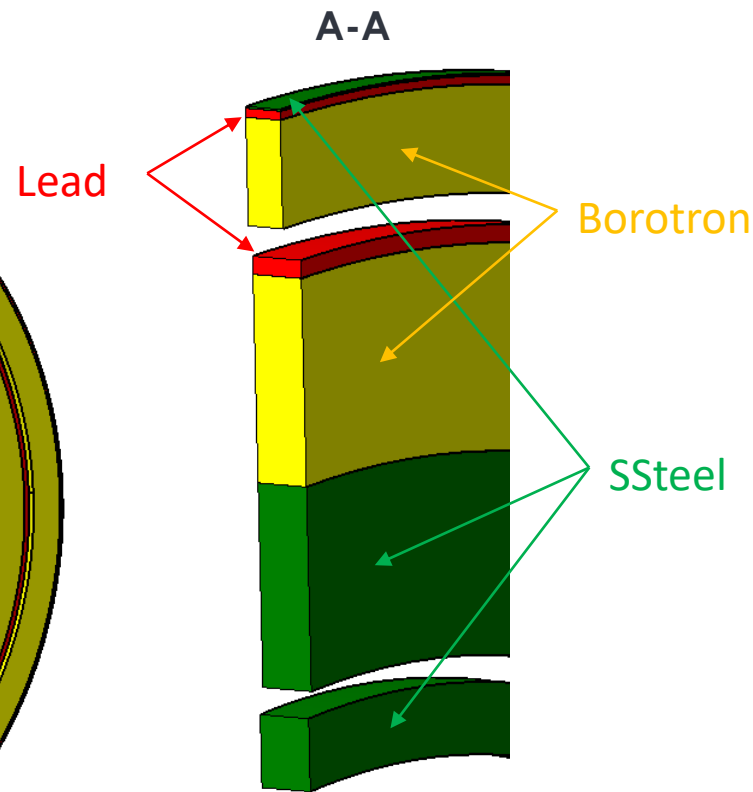
Vertical shield 7 parts

Simplified

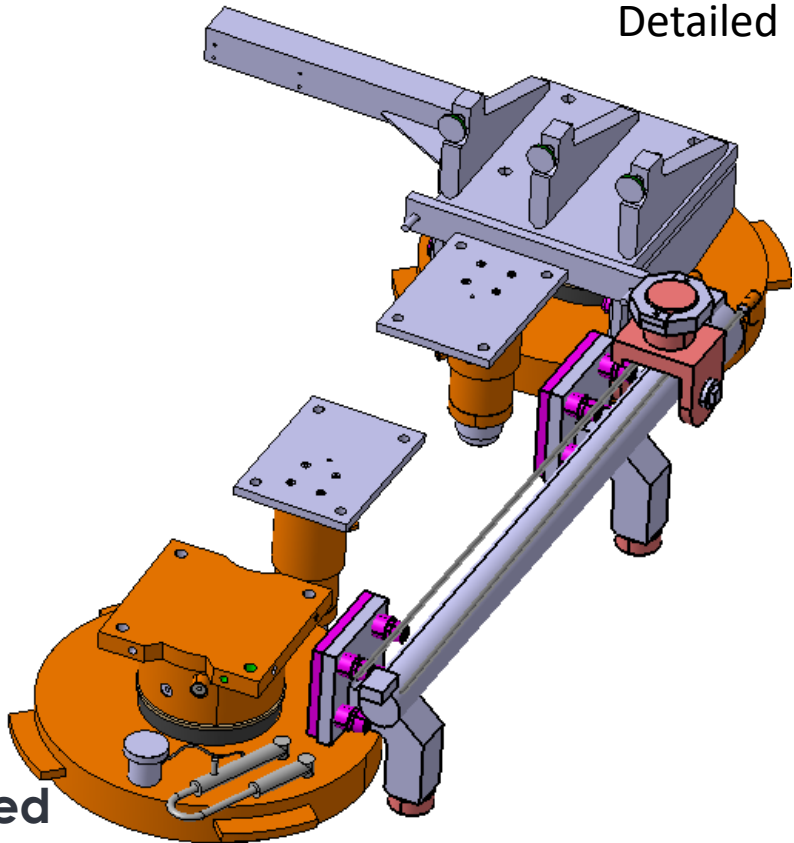
0.395 m<sup>3</sup>  
VOLUME

1741 kg  
WEIGHT

Diff. 8 kg



Detailed

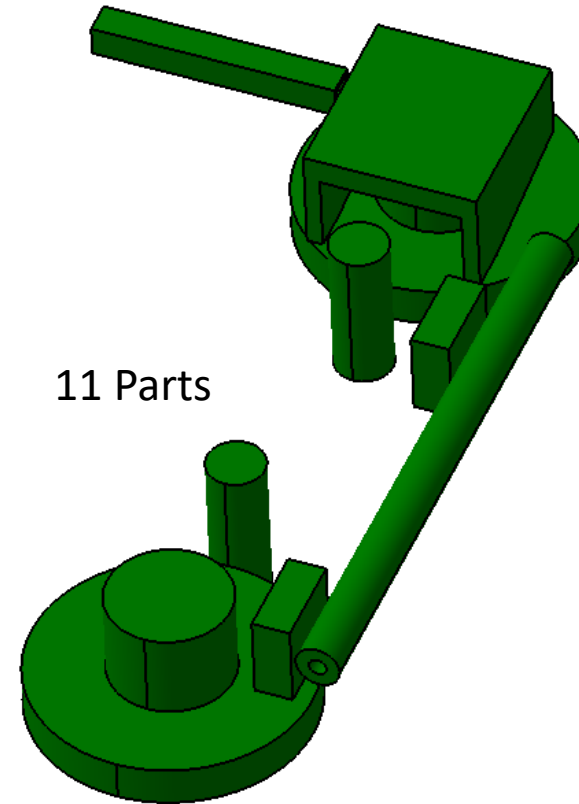


Detailed

**0.1733 m<sup>3</sup>**  
VOLUME

**1360.4kg**  
WEIGHT

Simplified



11 Parts

Simplified

**0.1733 m<sup>3</sup>**  
VOLUME

**1360.4kg**  
WEIGHT

Diff. 0kg

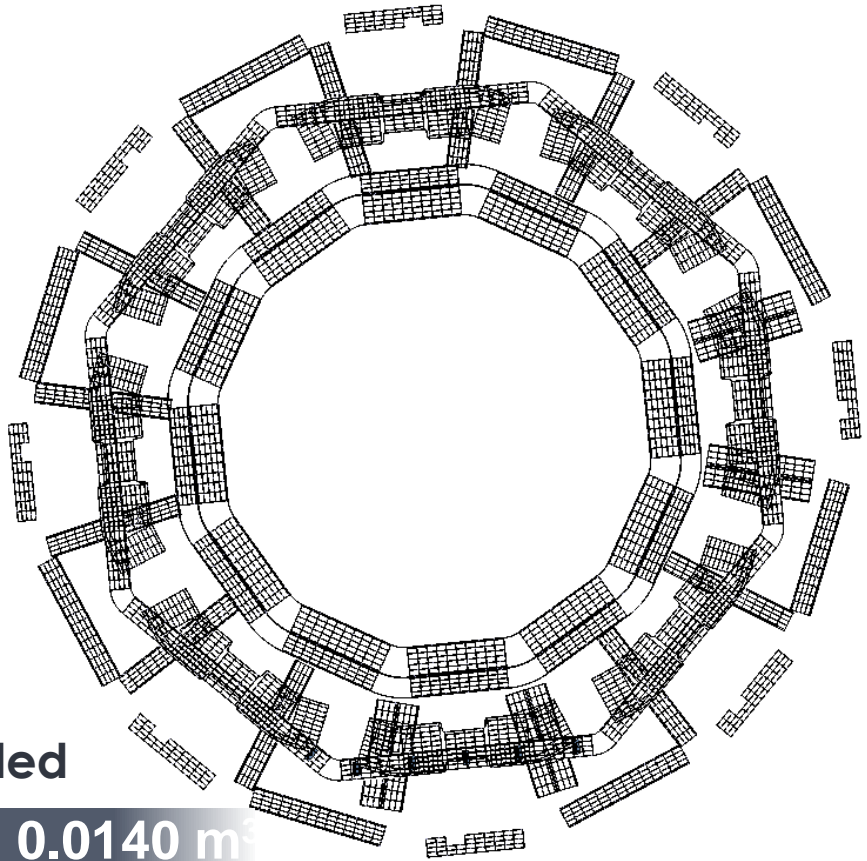


2 x per side = 2'720.8 kg



Material	Density
SSteel	8000

Detailed

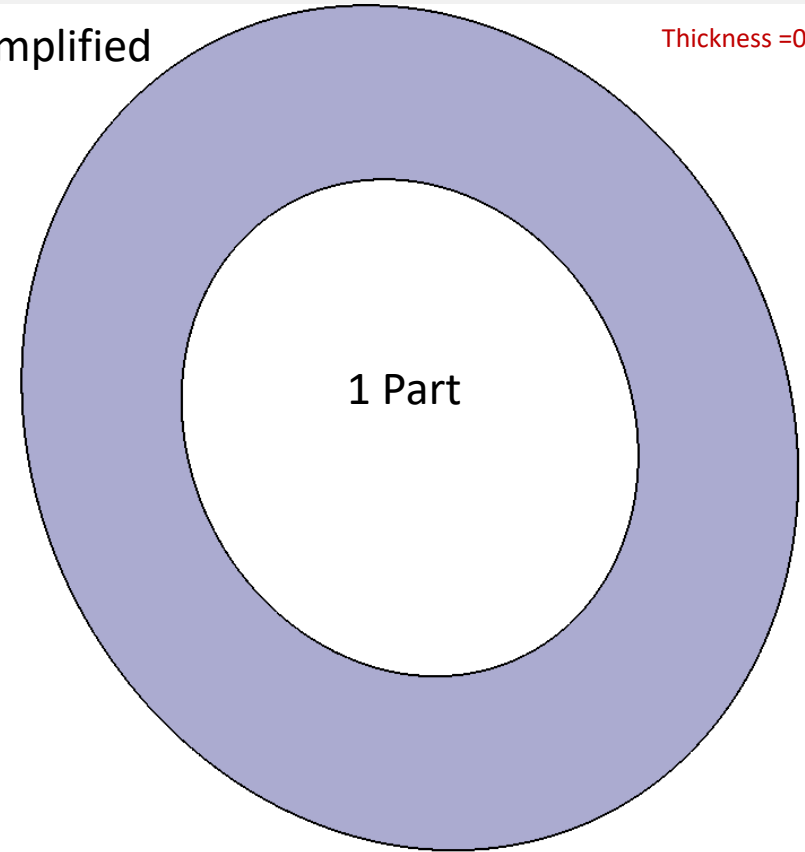


Detailed

**0.0140 m<sup>3</sup>**  
VOLUME

**113kg**  
WEIGHT

Simplified



Thickness = 0.5mm

1 Part

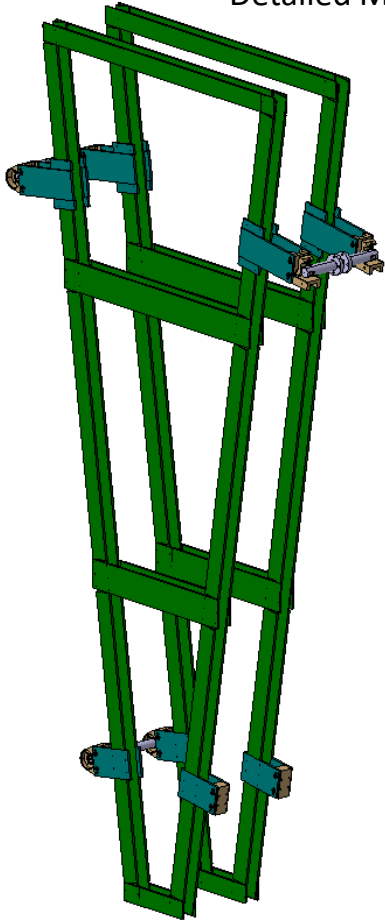
Simplified

**0.0143 m<sup>3</sup>**  
VOLUME

**115 kg**  
WEIGHT

Diff. 2kg

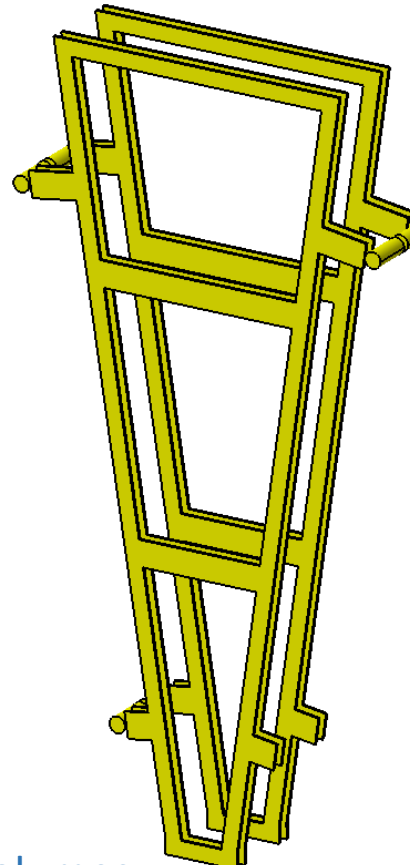
Detailed Model



8x

Total Volume (m <sup>3</sup> )	0.338
Total Mass (kg)	870
Material	Fiber grass FR4, Stainless Steel
Density (kg/m <sup>3</sup> )	1850, 8000

Simplified Model

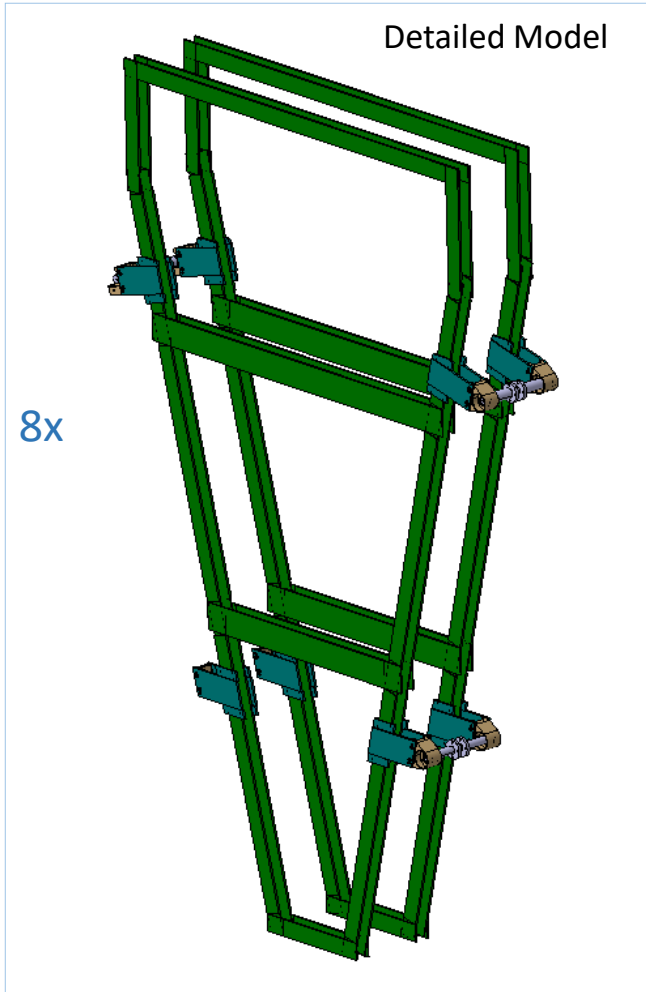


8x

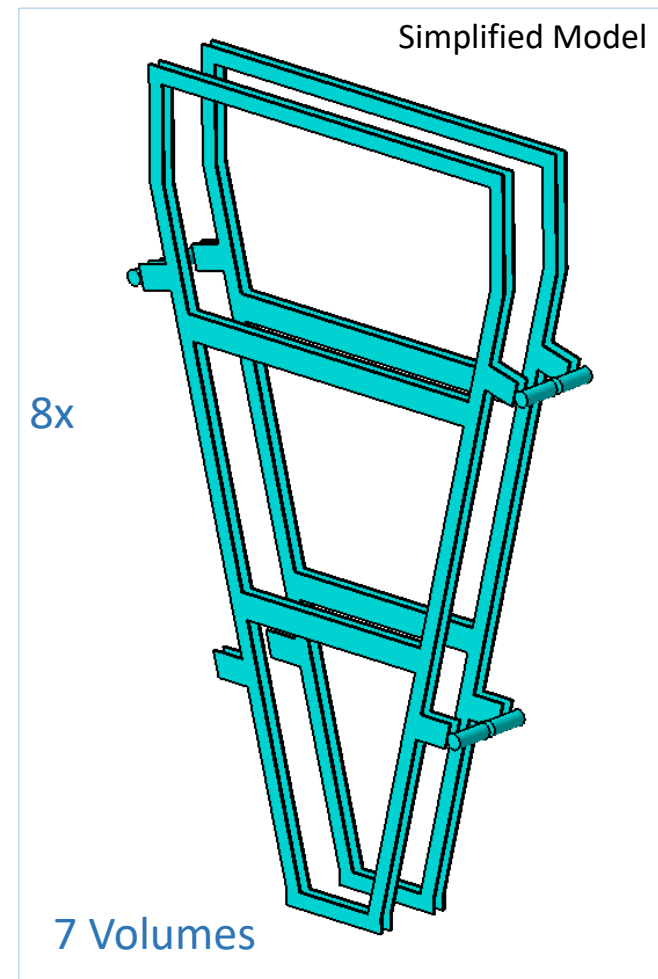
7 Volumes

Total Volume (m <sup>3</sup> )	0.339
Total Mass (kg)	873.9
Material	Fiber grass FR4, Stainless Steel
Density (kg/m <sup>3</sup> )	1850, 8000

**Diff: 3.9 Kg**



Total Volume (m <sup>3</sup> )	0.425
Total Mass (kg)	1031
Material	Fiber grass FR4, Stainless Steel
Density (kg/m <sup>3</sup> )	1850, 8000

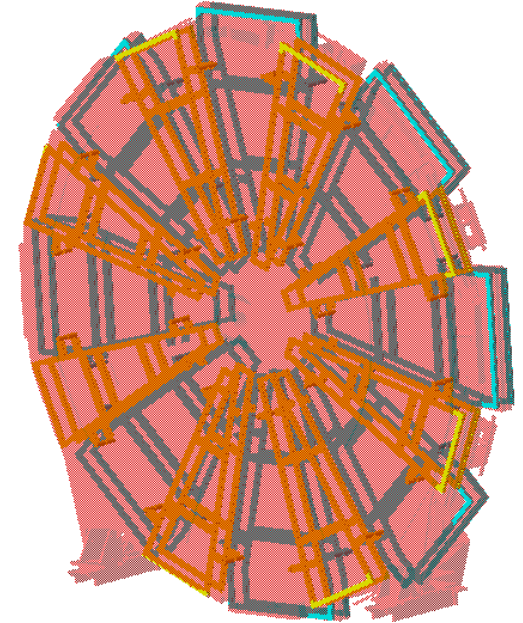
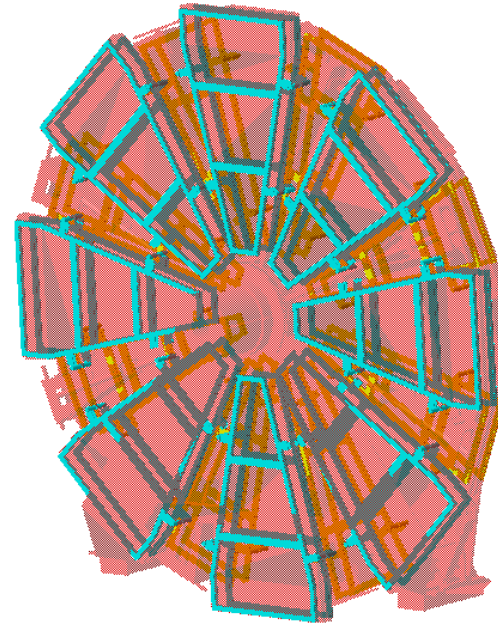
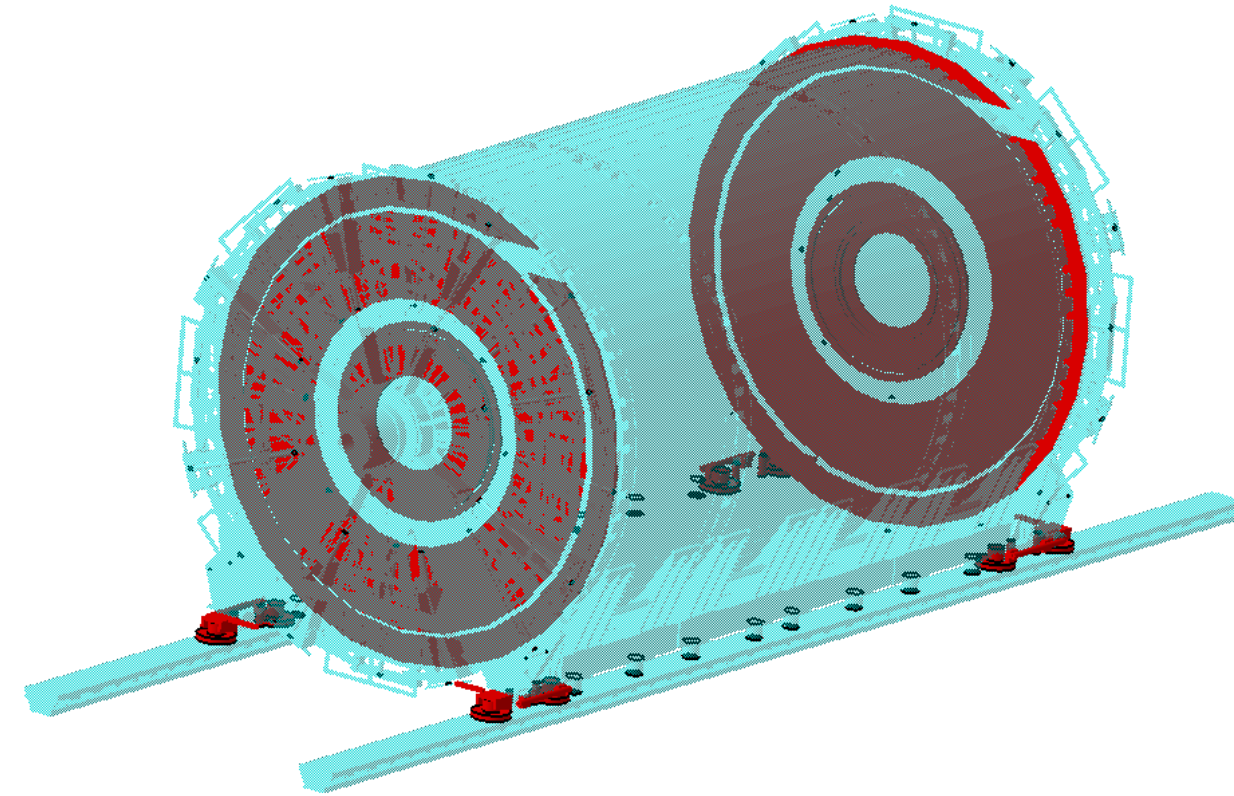


Total Volume (m <sup>3</sup> )	0.426
Total Mass (kg)	1034.2
Material	Fiber grass FR4, Stainless Steel
Density (kg/m <sup>3</sup> )	1850, 8000

**Diff: 3.2 Kg**



There are no internal / external overlaps or contacts





## Fragment of new AGDD/XML Description (Shield+Movement+Cables)

```

!-- NSW movement -->
tubs name="JD_PAD" material="Iron" Rio_Z="0.; 352.75; 105." nbPhi="36" />
tubs name="JD_TOP_Pad" material="Iron" Rio_Z="0.; 155.8; 226.4" nbPhi="36" />
tubs name="BJ_asse" material="Iron" Rio_Z="0.; 73.; 380." nbPhi="36" />
box name="YbracketN" material="Iron" X_Y_Z="95.88; 230.; 218." />
tubs name="VerinN" material="Iron" Rio_Z="22.5; 55.65; 1477." nbPhi="36" />

box name="Bracket_FC_Main" material="Iron" X_Y_Z="613.; 80.; 80." />
box name="Bracket_FC_CutBox" material="Iron" X_Y_Z="650.; 57.; 57." />

subtraction name="Bracket_FC">
  <posXYZ volume="Bracket_FC_Main" />
  <posXYZ volume="Bracket_FC_CutBox" />
/subtraction>

gvxy name="NSW_Extension_Main" material="Iron" dz="436.">
  <gvxy_point X_Y="-239.4; -126.1"/>
  <gvxy_point X_Y="-239.4; 126.1"/>
  <gvxy_point X_Y="239.4; 126.1"/>
  <gvxy_point X_Y="239.4; -52.78"/>
  <gvxy_point X_Y="-139.4; -126.1"/>
/gvxy>

box name="NSW_Extension_CutBox" material="Iron" X_Y_Z="314.; 270.2; 480." />

subtraction name="NSW_Extension">
  <posXYZ volume="NSW_Extension_Main" rot="0. ; 90. ; 0." />
  <posXYZ volume="NSW_Extension_CutBox" X_Y_Z="0.; -58.2; 0." />
/subtraction>

```



XML code (190 strings) is on Gitlab: [https://gitlab.cern.ch/asharmaz/atlas-g4-xml/..NSW/NSW\\_Missing\\_Parts/NSW\\_MissingParts.xml](https://gitlab.cern.ch/asharmaz/atlas-g4-xml/..NSW/NSW_Missing_Parts/NSW_MissingParts.xml)

## Fragment of new AGDD/XML Description (EIS/EIL)

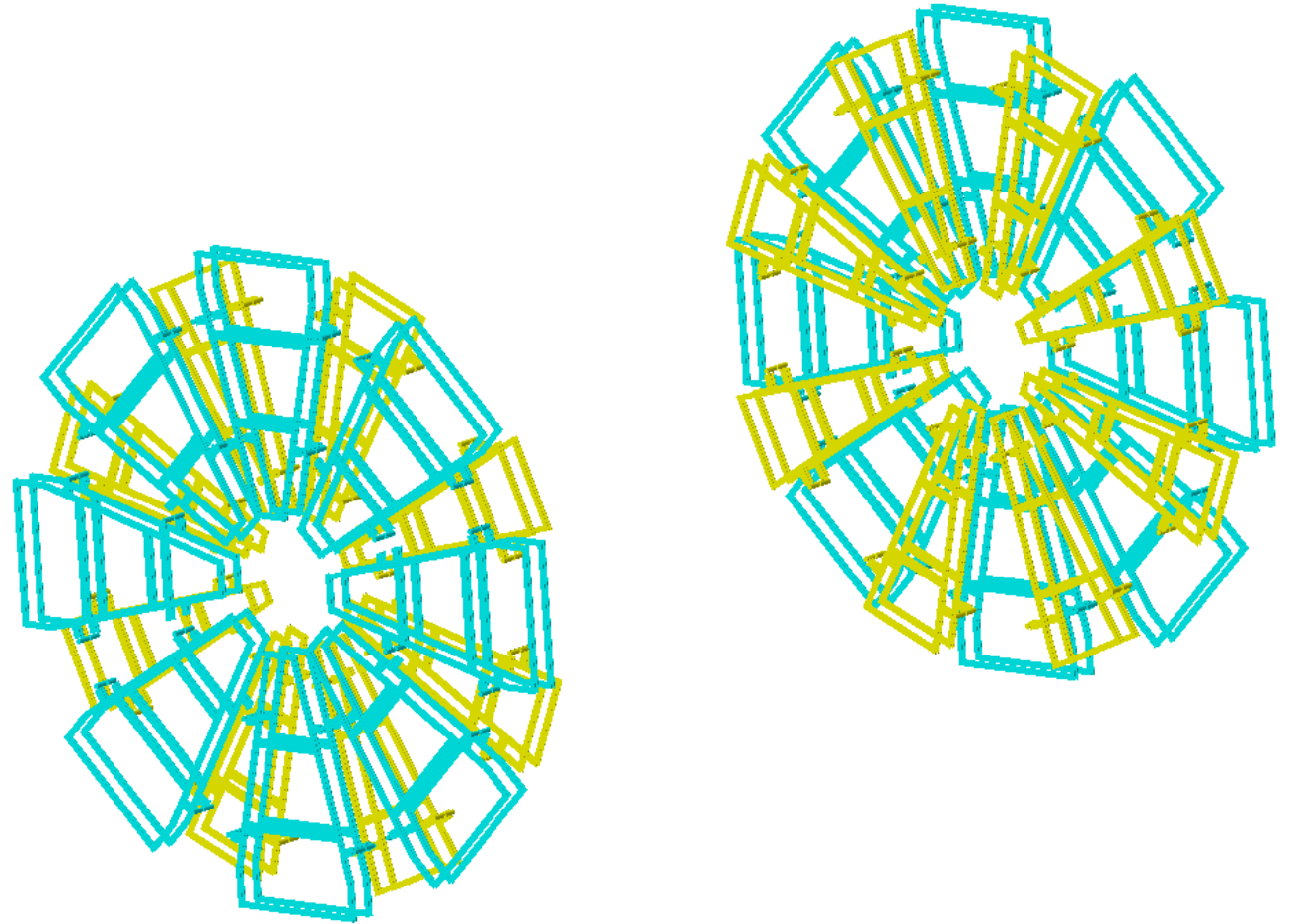
```
subtraction name="LS_Frame" >
  <posXYZ volume="LS_Frame_Main" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.;0." />
  <posXYZ volume="LS_Frame_Sub1" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.;0." />
  <posXYZ volume="LS_Frame_Sub2" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.;0." />
  <posXYZ volume="LS_Frame_Sub3" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.;0." />
/subtraction>

tubs name="LM_LS_Fixed_Interfaces_main" material="ShieldSteel" Rio_2="0.; 37.4; 410." nbPhi="32"/>

subtraction name="LM_LS_Fixed_Interfaces" >
  <posXYZ volume="LM_LS_Fixed_Interfaces_main" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.;0." />
  <posXYZ volume="LM_SS_Fixed_Interfaces_Subtr" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.;0." />
/subtraction>

composition name="LS_Frame_Assembly" >
  <posXYZ volume="LS_Frame" X_Y_Z=" 0.; 0.; 136.7" rot=" 0.; 0.; 0." />
  <posXYZ volume="LS_Frame" X_Y_Z=" 0.; 0.; -136.7" rot=" 0.; 0.; 0." />
  <posXYZ volume="LS_Frame" X_Y_Z=" 0.; 0.; 197.3" rot=" 0.; 0.; 0." />
  <posXYZ volume="LS_Frame" X_Y_Z=" 0.; 0.; -197.3" rot=" 0.; 0.; 0." />
  <posXYZ volume="LM_LS_Fixed_Interfaces" X_Y_Z=" 1139.32; 3615.; 0." rot=" 0.; 0.; 0." />
  <posXYZ volume="LM_LS_Fixed_Interfaces" X_Y_Z=" -1139.32; 3615.; 0." rot=" 0.; 0.; 0." />
  <posXYZ volume="LM_LS_Fixed_Interfaces" X_Y_Z=" -720.55; 1935.83; 0." rot=" 0.; 0.; 0." />
/composition>



composition name="LS_Frame_Assembly_Pos" >
  <posXYZ volume="LS_Frame_Assembly" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.; 0." />
  <posXYZ volume="LS_Frame_Assembly" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.; 45." />
  <posXYZ volume="LS_Frame_Assembly" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.; 90." />
  <posXYZ volume="LS_Frame_Assembly" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.; 135." />
  <posXYZ volume="LS_Frame_Assembly" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.; 180." />
  <posXYZ volume="LS_Frame_Assembly" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.; 225." />
  <posXYZ volume="LS_Frame_Assembly" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.; 270." />
  <posXYZ volume="LS_Frame_Assembly" X_Y_Z=" 0.; 0.; 0." rot=" 0.; 0.; 315." />
/composition>
<!-- End SS Frame -->
```








XML code (162 strings) is on Gitlab: [https://gitlab.cern.ch/asharmaz/atlas-g4-xml/./NSW/LS\\_SS\\_frames.xml](https://gitlab.cern.ch/asharmaz/atlas-g4-xml/./NSW/LS_SS_frames.xml)

All technical reports are on Gitlab: <https://gitlab.cern.ch/asharmaz/atlas-g4-xml>

2nd-push ▾ atlas-g4-xml / NSW / NSW\_Missing\_Parts / + ▾ History Find file Web IDE Download ▾

 **Simplification Report**  
Niko Tsutskiridze authored 1 minute ago 80b878e5 

Name	Last commit	Last update
..		
 .gitkeep	Vertical Shielding HO, NJD Vert Shield, Cable Tray...	21 hours ago
 3DModelofMissingParts.wrl	.wrl file of AGDD/XML implementation	21 hours ago
 ConflictChecking_and_Codding.pdf	Reports of "Integration conflicts checking and AG...	20 hours ago
 NSW_MissingParts.XML	Update NSW_MissingParts.XML	20 hours ago
 simplification.pdf	Simplification Report	1 minute ago

Heavy

Item	Item Name	Calc	Sim	C-Check	XML	Status
1	Vertical Shield HO	✓	✓	✓	✓	Finished
2	NJD Vertical Shield	✓	✓	✓	✓	Finished
3	NSW Movement	✓	✓	✓	✓	Finished
4	EIS (sTGC KMs) SS Frame	✓	✓	✓	✓	Finished
5	EIL (sTGC KMs) LS Frame	✓	✓	✓	✓	Finished
6	LV crate concept	✓	✗	✗	✗	Waiting Answers
7	Main Pipes	✓	✗	✗	✗	Waiting Answers
8	Brackets	✓	✗	✗	✗	Waiting Answers
9	Alignment Boxes	✓	✗	✗	✗	Waiting Answers

Total: 12'700 kg

# Current Status of the Project

Slight

Item	Item Name		Sim	C-Check	XML	Status
1	Rim Plates	✓	✓	✓	✓	Finished
2	Cable Trays	✓	✓	✓	✓	Finished
3	LS Spoke/Supports/ Rod & Bumpers	✓	✓	✓	✓	Finished
4	Flexible Chain Brackets	✓	✗	✗	✗	Waiting Answers
5	Gas Manifolds	✓	✗	✗	✗	Waiting Answers
6	Sec Pipes	✓	✗	✗	✗	Waiting Answers
7	Rim Crate	✓	✗	✗	✗	Waiting Answers
8	Lower BrackerG Pipes	✓	✗	✗	✗	Waiting Answers
9	Routing Hydraulic Pipes	✓	✗	✗	✗	Waiting Answers
10	protec_V2	✓	✗	✗	✗	Waiting Answers
11	THREE STAR MTP-12LC MODULE	✓	✗	✗	✗	Waiting Answers
12	HV_MM_SPLITTER	✓	✗	✗	✗	Waiting Answers
13	Alignment Boxes Support	✓	✗	✗	✗	Waiting Answers
14	Cable tray on IP side_V2	✓	✗	✗	✗	Waiting Answers

Total: 1'500 kg



Comments are welcome,

Thanks!