GEANT-4 Geometry Descriptions Study Report from the Georgian Team

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https://indico.cern.ch/event/785991/

AA366/10 Addendum-V

New Agreement has been signed for 2019



- 2019 Agreement has 5 Working Packages. 3 of them concern with GEANT-4 Geometry Descriptions development
- WP1: Adding New Volumes in Geant4 Baseline Geometry
- WP2: Material checks for the New Small Wheel
- WP5: Development of Reference Geometry database of ATLAS Detector

Methodology

 We are using CATIA as a hub for collection of various geometry descriptions



- Having CATIA as a Geometry hub we can make different analyses Like:
 - 1. XML-vs-As_Built
 - 2. GeoModel-vs-As_Built
 - 3. Geant-vs-As_Built
- We have developed life cycle for analyses and new volumes preparation
- We have 9 steps

<u>01</u>: Reproduction of 3D geometry from S-Team



Case Study:

- ECT Project: 902 Drawings added
- Coils Project: 225 Drawings added
- MDT Structure: 74 Drawings added
- Warm Structure: 127 Drawings added

<u>02</u>: Getting GEANT-4 model in CATIA



<u>03</u>: Structuration of CATIA model according to GEANT-4 model

Separation volumes in CATIA model

04: Compare Analyses: CATIA-vs-GEANT



05: Report Submission on Simulation/Muon meetings



<u>06</u>: Simplification of CATIA Volumes



07: XML generation

Extracting parameters values from CATIA model

Fill amdb_simrec Tamplets

08: Integration Conflicts checking



<u>09</u>: Modification SIM-XML Gitlab repository



Wish list from Experts

- Laurent propose to investigate:
 - 1. Supports in MS, Sector 5 eta=[-1,1] and Sector 12 eta=[1, 2.7]
 - 2. Barrel in Sector 3 (large chambers) eta<1 including all services
 - 3. An RZ view of different supports in MS, all have in common a Boolean construction and potential overlap. So, we need to,



- 1. Investigate of overlaps and in same time Muon people should check data/MC for sector 5 and 12
 - If sector 5 eta=[-1,1] shows a large discrepancy data/MC, continue by checking voussoirs (Boolean construction) and struts ...
 - If not and if the sector 12 is wrong, start by stadying around wta=1.5 which could be wrongly done: shielding description, missing services, etc.
 - Take a "good" sector in the barrel i.e. sector 3(large chambers) only in the barrel eta<[1] and start a list of services which are in this part (estimate the weight of each part)

Wish list from Experts

- ADA propose to investigate:
 - 1. Existing XML of full Toroid
 - 2. EndCAP Toroid for missing materials

- Markus ELSING propose to investigate:
 - 1. Overlaps in existing GeoModel descriptions

- Zach, Laurent, ADA, Jochen propose:
 - 1. to have "as-built" geometry in CATIA for reference

Calorimeter Services



Calorimeter Services





GeoMODEL Services



Muon Services



Muon Services





Magnet Services



Magnet Services





JD Services



IVIUON SOTTWARE IVIEEting 14 March, 2019

JD Services





Racks, Cable Trays



Racks, Cable Trays





Cooling and Gas Pipes



Cooling and Gas Pipes



It was agreed by Christoph and Jochen



GAP Region



GAP Region

- R08 : Electronic Boxes
 R09 : LA Drain Line
 R10 : LA Pump
 R11 : By Pass Tube
- 5 R13 : LN2-GN2 Lines
- 6 R14 : Cryostat Safety Line
- 7 R15 : Solenoid Line
- 8 R16 : Middle Services S1 Supports
- 9 R17 : Middle Services S1 Cabels
- 10 R18 : Middle Services S1 Pipes

Middle Services



Outer Services



GAP Region

R08 – Electronic Boxes



1 R08 : Electronic Boxes

- 2 R09 : LA Drain Line
- **3** R10 : LA Pump
- 4 R11 : By Pass Tube
- 5 R13 : LN2-GN2 Lines
- 6 R14 : Cryostat Safety Line
- 7 R15 : Solenoid Line
- 8 R16 : Middle Services S1 Supports
- 9 R17 : Middle Services S1 Cabels
- **10** R18 : Middle Services S1 Pipes

GAP Region

R09 – LA Drain Line

1 R08 : Electronic Boxes
2 R09 : LA Drain Line
3 R10 : LA Pump
4 R11 : By Pass Tube
5 R13 : LN2-GN2 Lines
6 R14 : Cryostat Safety Line
7 R15 : Solenoid Line
8 R16 : Middle Services – S1 Supports
9 R17 : Middle Services – S1 Cabels
🔟 R18 : Middle Services – S1 Pipes



GAP Region

R10 – LA Pump



- 2 R09 : LA Drain Line
- **3** R10 : LA Pump
- 4 R11 : By Pass Tube
- 5 R13 : LN2-GN2 Lines
- 6 R14 : Cryostat Safety Line
- 7 R15 : Solenoid Line
- 8 R16 : Middle Services S1 Supports
- 9 R17 : Middle Services S1 Cabels
- 10 R18 : Middle Services S1 Pipes



GAP Region

R11 – By Pass Tube



- 2 R09 : LA Drain Line
 3 R10 : LA Pump
 4 R11 : By Pass Tube
- 5 R13 : LN2-GN2 Lines
- 6 R14 : Cryostat Safety Line

R08 : Electronic Boxes

- 7 R15 : Solenoid Line
- 8 R16 : Middle Services S1 Supports
- 9 R17 : Middle Services S1 Cabels
- **10** R18 : Middle Services S1 Pipes

GAP Region

R13 – LN2-GN2 Lines



GAP Region

R14 – Cryostat Safety Line



GAP Region

R10 : LA Pump

R15 – Solenoid Line



GAP Region

R16 – Middle Services – S1 Supports



GAP Region

R17 – Middle Services – S1 Cables





10 R18 : Middle Services – S1 Pipes

GAP Region

R18 – Middle Services – S1 Pipes







1 R08 : Electronic Boxes

- 2 R09 : LA Drain Line
- **3** R10 : LA Pump
- 4 R11 : By Pass Tube
- 5 R13 : LN2-GN2 Lines
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10 R18 : Middle Services – S1 Pipes

- 9 big projects have been done
- <u>Conclusion</u>: GEANT-4 geometry is far away from as-built geometry





Compare Analyses

Model	Volume (m3)	Weight (kg)	Difference (kg)
CATIA	24.75	92130	
G4	22.13	80453	-11677



Geometrical Inaccuracy ~ 100 kg

- Coils Study
- TGC1
- TGC2-3
- MDT
- ECT
- Heavy Truck
- ECT Tower
- Flx-Chain S9
- Integration

Weight Discrepancy Between CATIA and XML

TCC22	V	/olume (m³)		Weight (kgs)				
IGC 2-5	CATIA	XML	Diferance	CATIA	XML	Diferance		
Outer Geometry	2.1552	0.7725	1.3827	5819	2086	3733		
Middle Geometry	2.9936	2.0126	0.981	8083	5434	2649		
Inner Geometry	0.265	0.1033	0.1617	716	279	437		
Total	5.4138	2.8884	2.5254	14617	7799	6819		



- Coils Study
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Compare Analyses

Model	Material	Density (kg/m3)	Volume (m ³)	Weight (kgs)	Missing (kgs)
CATIA	Aluminum/Stainl ess Steel	2700 / 8000	3.6723	10'532	
PERSINT/XML	Aluminum	2700	2.3184	6'260	-4'272

CATIA Model



GEANT-4 Model



• Coils Study

- TGC1
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Source geometry has been taken from SmarTeam Engineering Database:

Path: ATLAS CURRENT/Detector System/Magnets ATLAS/Toroid Magnets ATLAS/Barrel Toroid MagnetModel:ST0268528 ECT assembly side C (id: CAD000628534)

Missing parts have been created from 902 CDD Drawings

		CATIA		XML		Difference	%
1	Cold Mass	116740	kgs	123012	kgs	+6'272 kgs	5.4 %
2	Thermal Shielding	15988	kgs	15957	kgs	-31 kgs	0.2 %
3	Cover	57966	kgs	57185	kgs	-781 kgs	1.3 %
4	Bore Tube	13433	kgs	10208	kgs	-3′225 kgs	24.0 %
5	Yoke	1820	kgs	1338	kgs	-483 kgs	26.5 %
6	Stay Tube	2028	kgs	2214	kgs	+186 kgs	9.2 %
7	JTV Shielding	4161	kgs	4510	kgs	+349 kgs	8.4 %
8	Turret	2476	kgs	1512	kgs	-964 kgs	38.9 %
9	Tie Rod	3077	kgs	1268	kgs	-1'809 kgs	58.8 %
10	Bolts/	2965	kgs			-2'965 kgs	100.0 %
11	Services	869	kgs			-869 kgs	100.0 %
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• Coils Study

- TGC1
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Heavy Truck

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SmarTeam doc. N: ST0267137_01 Last Modification: 08/05/2015

GEANT-4 Geometry XML Release: amdb_simrec.r.08.01





VS

	SmarTeam		SmarTeam			ant4	Δ	Mass Difference
	Volume / m³	Mass / kg	Volume / m³	Mass / kg	kg	%		
RAILS	1.24	9734	1.5905	12517.2	-2783.2	22.2		
BEAM	1.302	10220.7	1.7935	14114.8	-3894.1	27.6		
COLUMN C1-L, C2-R	3.154	24758.9	2.747	21618.9	3140	12.7		
BRACING	0.53	4160.5	0.1365	368.6	3791.9	91.1		
HFTruckRail	0	0	0.576	4533.1	-4533.1	100.0		
SERVICES	0.107	840	0	0	840	100.0		
Brackets	0.48	3768	0	0	3768	100.0		
Infrastructure	0.292	2292.2	0	0	2292.2	100.0		
SHIMS	0.132	1036.2	0	0	1036.2	100.0		

- Coils Study
- TGC1
- TGC2-3
- **MDT**
- ECT
- **Heavy Truck**

ECT Tower ۲

- Flx-Chain S9
- Integration

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Slide No	Name	Geant4		SmarTeam			Difference			
Silue N2	Name	Volume (m³)	Mass (kg)	Volume (m ³)	Mass (kg)		Volu	me	Ma	ss
							m ³		kg	
4	ECST Left Leg Cover	0.255	688.5	0.048	129.6		0.207	77%	558.9	81%
5	ECST Left Leg Rod	0.24	648	0.069	186.3		0.171	60%	461.7	71%
6	ECST Right Leg	0.28	756	0.091	245.7		0.189	52%	510.3	68%
7	ECST Middle and Inclined Bars	0.064	172.8	0.0895	241		-0.0286	68%	-68.2	28%
8	ECST Front	0.062	167.4	0.045	121.5		0.017	62%	45.9	27%
9	ECST Front Glass	0.157	342.1	0.0258	696.6		0.131	84%	-354.5	51%
10	ECT ServTur	0.048	129.6	0.056	448		-0.008	14%	-318.4	71%
11	ECST Cop	0	0	0.5075	1689.5		-0.508	100%	-1689.5	100%
12	ECST Pipes	0	0	0.011	88		-0.011	100%	-88	100%
13	ECST Bottom Plates	0	0	0.0494	133.38		-0.05	100%	-133.4	100%
	Total:	1.106	2904.4	0.9922	3979.58		0.1138	72%	-1075.2	70%



ST0736882_01



- Coils Study
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		CATIA	Geant	Difference
1 2 3 4 5	Support Drag Chain Towing Arm Pipes Cables	1'968 kgs 1'608 kgs 680 kgs 172 kgs 825 kgs	11'877 kgs - kgs - kgs - kgs - kgs - kgs	83.4% - 100% - 100% - 100% - 100%
	Total	5'253	11'877	97%

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CATIA

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- Integration Conflicts Analyses
- COIL's + Warm Structure Displacement

 $\begin{array}{l} \Delta_{_{\rm NL}} = R1 |_{_{CATIA}} \; - \; R1 |_{_{XML}} \; = 9515 \; mm - 9480 \; mm = 35 \; mm \\ \Delta_{_{\rm NL}} = R2 |_{_{CATIA}} \; - \; R2 |_{_{XML}} \; = 5295 \; mm - 5270 \; mm = 25 \; mm \end{array}$

• Warm Structure Clashes





Warm Structure Clashes





- Coils Study
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There Are No Integration Conflicts

External Conflicts of ECT

Muon Software Meeting 14 March, 2019

Clash 2,86mm

Actual ToDo list for G-Team (WP1-Adding)



Actual ToDo list for G-Team (WP2-Compare)



Thank you