

Change of Cgem Geometry and Material

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Outline

- 1. compare the new geometry and the old geometry
- 2. compare the material burget
- 3. update geometry and GDML file
- 4. Fitting result

Geometry

	Layer 1 (L=532 mm)				Layer 2 (L=690 mm)				Layer 3 (L=847 mm)			
	New		Old		New		Old		New		Old	
	R_{in} (mm)	T (mm)	R_{in} (mm)	T (mm)	R_{in}	T	R_{in}	T	R_{in}	T	R_{in}	T
Cathode	76.915	2.14	75.234	3.104	121.415	2.14	120.5	3.104	161.915	2.14	163.0	3.104
Gap D	79.055	5.0	78.338	3.0	123.555	5.0	123.604	3.0	164.055	5.0	166.104	3.0
GEM foil	84.055	0.056	81.338	0.054	128.555	0.056	126.604	0.054	169.055	0.056	169.104	0.054
Gap T1	84.111	2.0	81.392	2.0	128.611	2.0	126.658	2.0	169.111	2.0	169.158	2.0
GEM foil	86.111	0.056	83.392	0.054	130.611	0.056	128.658	0.054	171.111	0.056	171.158	0.054
Gap T2	86.167	2.0	83.446	2.0	130.667	2.0	128.712	2.0	171.167	2.0	171.212	2.0
GEM foil	88.167	0.056	85.446	0.054	132.667	0.056	130.712	0.054	173.167	0.056	173.212	0.054
Gap I	88.223	2.0	85.5	2.0	132.723	2.0	130.766	2.0	173.223	2.0	173.266	2.0
Anode	90.223	4.2375	87.5	0.2512	134.723	4.2375	132.766	0.2512	175.223	4.2375	175.266	0.2512
Shield			87.7512	3.1			133.017	3.1			175.517	3.1
Separator									182.5	1.0		

Note: Gap D is the drift area

Readout Plane

	Layer 1		Layer 2		Layer 3	
	new	old	new	old	new	old
Sheet number	1	1	2	2	2	2
Anode Radius(mm)	90.225	87.5	134.725	132.766	175.225	175.266
Layer width(mm)	549.78	549.78	416.26	416.26	549.78	549.78
Z length(mm)	532	532	690	690	847	847
Stereo angle(deg)	43.314	45.94	31.3	31.1	32.99	32.99
X Pitch width(mm)	0.66	0.65	0.66	0.65	0.66	0.65
X Strip width(mm)	0.58	0.3	0.58	0.3	0.58	0.3
V Pitch width(mm)	0.659	0.65	0.659	0.65	0.659	0.65
V Strip width(mm)	0.13	0.3	0.13	0.3	0.13	0.3

Material Budget (for 1 layer)

	new		old	
material	T (mm)	T/X_0 (%)	T (mm)	T/X_0 (%)
Cgem gas	11.0	0.00823	9.0	0.00673
Cu	0.038	0.26470	0.022	0.15325
Kapton	0.3625	0.12686	0.575	0.20123
Epoxy	0.145	0.04270	0.02	0.00589
Rohacell	6.0	0.04352		
Honeycomb			6.0	0.04572
Au			0.0002	0.00598
total	17.5455	0.4860	15.6172	0.4188

Material Budget (for 1 layer)

		new			old		
material		T (mm)	X_0 (mm)	T/X_0 (%)	T (mm)	X_0 (mm)	T/X_0 (%)
Cathode	Cu	0.005	14.3558	0.0348292	0.004	14.3558	0.0278634
	Kapton	0.075	285.747	0.02624689	0.1	285.747	0.034996
	Epoxy	0.06	339.598	0.01766796			
	Rohacell	2.0	13788.1	0.01450528			
	Honeycomb				3.0	13123.8	0.0228593
	sum	2.14		0.09325	3.104		0.08572
Gap	Cgem gas	11.0	133724	0.00823	9.0	133724	0.00673
GEM Foil	Cu	0.006×3	14.3558	0.125385	0.004×3	14.3558	0.0835902
	Kapton	0.05×3	285.747	0.052494	0.05 ×3	285.747	0.052494
	sum	0.168		0.17788	0.162		0.13608

Material Budget (for 1 layer)

		new			old		
material		<i>T</i> (mm)	<i>X₀</i> (mm)	<i>T/X₀</i> (%)	<i>T</i> (mm)	<i>X₀</i> (mm)	<i>T/X₀</i> (%)
Anode	Cu	0.015	14.3558	0.1044876	0.006	14.3558	0.0417951
	Kapton	0.1375	285.747	0.04811948	0.225	285.747	0.0787409
	Epoxy	0.085	339.598	0.02502961	0.02	339.598	0.00588932
	Rohacell	4.0	13788.1	0.0290106			
	Au				0.0002	3.34436	0.0059802
	sum	4.2375		0.20665	0.2512		0.13240
Shield	Kapton				0.1	285.747	0.034996
	Honeycomb				3.0	13123.8	0.0228593
	sum				3.1		0.05786
1 layer total				0.4860			0.4188
Layer Gap	Air	49.909	30392.1	0.01642169	56.5316	30392.1	0.01860074
separator	Carbon Fiber	1.0	253.831	0.393963			
Cgem Total		0.4860× 3 + 0.0164 + 0.3940=		1.868	0.4188× 3 + 0.0186=		1.275

Update Geometry in Different Packages

- Previously, Cgem geometrical parameters, such as radius, stereo angle... are written in the code of the packages.
- Now, all Cgem geometrical parameters should be obtain from the **CgemGeomSvc** package.
- Packages that need to be modified:
 1. CgemSim
 2. CgemClusterCreate
 3. CgemSegmentRecAlg
 4. CgemSegmentFitAlg
 5. CgemMdcCombAlg
 6. **KalFitAlg**

Update Material (update GDML file)

- 1. Modify [CgemSim/src/BesCgemConstrction.cc](#) to attach the **Cgem layer ID** to the G4VSolid, G4LogicalVolume and G4VPhysicalVolume in the produced GDML file.

```
263  /* Gap_D */
264
265  log<< MSG::INFO << "BesCgemConstrction::ConstructFromCode(), Construct CgemLayer
266
267  lvd_R_i = lv_CgemLayer.GetInnerROfGapD()*mm;
268  lvd_R_o = lv_CgemLayer.GetOuterROfGapD()*mm;
269  G4Tubs *lv_Gap_D_solid =
270      new G4Tubs("Gap_D_solid", lvd_R_i, lvd_R_o, lvd_L_z/2., lvd_A_s, lvd_A_d);
271  G4LogicalVolume *lv_Gap_D_logic =
272      new G4LogicalVolume(lv_Gap_D_solid, m_M_CgemGas, "Gap_D_logic");
273  G4VPhysicalVolume *lv_Gap_D_physi =
274      new G4PVPlacement(lv_rotation, lv_3vector, lv_Gap_D_logic, "Gap_D_physt",
275      lv_CgemLayer_logic, lv_boolen, lv_copyNo, m_CheckOverlaps);
276
```

```
494  /* Gap_D */
495
496  log<< MSG::INFO << "BesCgemConstrction::ConstructFromCode(), Construct
497
498  sssolid.str("");
499  sssolid << "Gap_D_solid";
500  sssolid << i;
501  ssolid = sssolid.str();
502  sslogic.str("");
503  sslogic << "Gap_D_logic";
504  sslogic << i;
505  slogic = sslogic.str();
506  ssphysi.str("");
507  ssphysi << "Gap_D_physi";
508  ssphysi << i;
509  sphysi = ssphysi.str();
510  lvd_R_i = lv_CgemLayer->getInnerROfGapD()*mm;
511  lvd_R_o = lv_CgemLayer->getOuterROfGapD()*mm;
512  G4Tubs *lv_Gap_D_solid =
513      new G4Tubs(sssolid, lvd_R_i, lvd_R_o, lvd_L_z/2., lvd_A_s, lvd_A_d);
514  G4LogicalVolume *lv_Gap_D_logic =
515      new G4LogicalVolume(lv_Gap_D_solid, m_M_CgemGas, slogic);
516  G4VPhysicalVolume *lv_Gap_D_physi =
517      new G4PVPlacement(lv_rotation, lv_3vector, lv_Gap_D_logic, sphysi,
518      lv_CgemLayer_logic, lv_boolen, lv_copyNo, m_CheckOverlaps);
519
```

Update Material (update GDML file)

1. Modify [BesSim/src/BesSim.cc](#)

```
218 G4VPhysicalVolume* g4wv =G4TransportationManager::GetTransportationManager()-> GetNavigatorForTracking()->GetWorldVolume(); //
is for storing TOF GDML
219 //G4GDMLWriter g4writerBes("/afs/ihep.ac.cn/bes3/offline/sw/packages/BesGDML/2.8.0/GDMLSchema/gdml.xsd", "Bes.gdml",2);
220 //G4GDMLWriter g4writerMdc("/afs/ihep.ac.cn/bes3/offline/sw/packages/BesGDML/2.8.0/GDMLSchema/gdml.xsd", "Mdc.gdml",2);
221 G4GDMLWriter g4writerCgem("/afs/ihep.ac.cn/bes3/offline/sw/packages/BesGDML/2.8.0/GDMLSchema/gdml.xsd", "Cgem.gdml",2);
222 //G4GDMLWriter g4writerTof("/afs/ihep.ac.cn/bes3/offline/sw/packages/BesGDML/2.8.0/GDMLSchema/gdml.xsd", "Tof.gdml",2); //Apply
r storing TOF GDML
223 //G4GDMLWriter g4writerEmc("/afs/ihep.ac.cn/bes3/offline/sw/packages/BesGDML/2.8.0/GDMLSchema/gdml.xsd", "Emc.gdml",2);
224 //G4GDMLWriter g4writerMuc("/afs/ihep.ac.cn/bes3/offline/sw/packages/BesGDML/2.8.0/GDMLSchema/gdml.xsd", "Muc.gdml",2);
225 try
226 {
227 //g4writerBes.DumpGeometryInfo(g4wv);
228 g4writerCgem.DumpGeometryInfo(g4wv->GetLogicalVolume()->GetDaughter(0)); //Changed from 0 to 3//Apply this for storing TOF GD
229 }
230 }
231 catch(std::logic_error &lerr)
232 {
233     std::cout << "Caught an exception: "
234     << lerr.what () << std::endl;
235 }
```

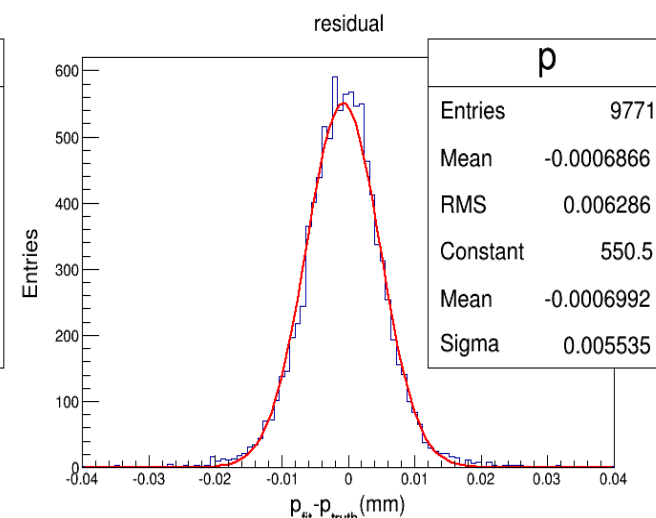
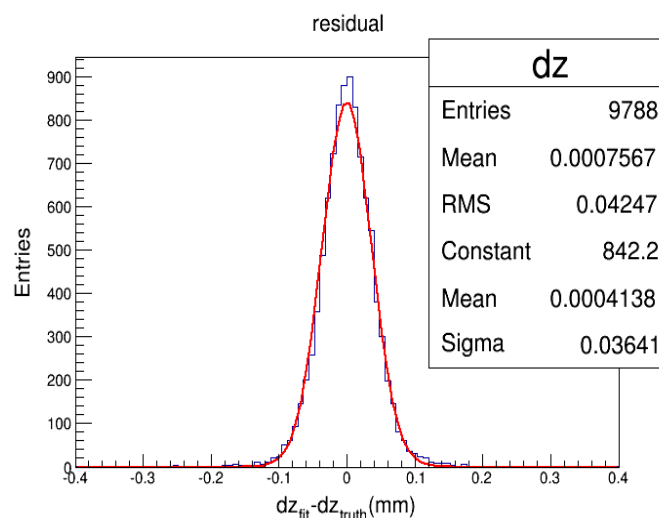
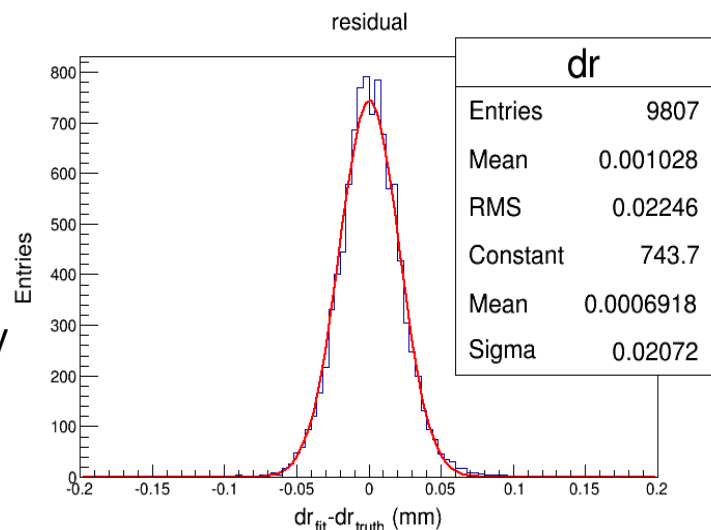
2. Modify [simulation jobOption file](#). Then replace Cgem.gdml file in [\\$GDMLMAGAGEMENTROOT](#)

```
35 //*****run simulation job without material of subdetectors*****
36 //0:no construct; 1:construct from G4 code; 2:construct from GDML(default)
37 BesSim.Cgem      = 1;
38 BesSim.Mdc       = 0;
39 BesSim.Tof       = 0;
40 BesSim.Emc       = 0;
41 BesSim.Muc       = 0;
42 BesSim.PipeSCM   = 0;
```

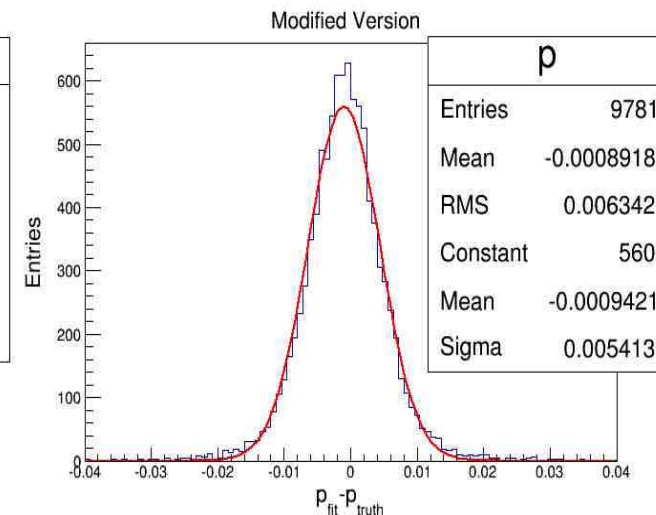
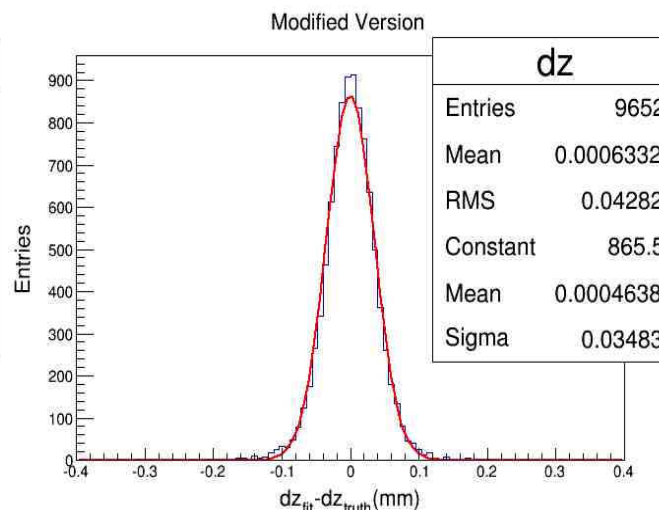
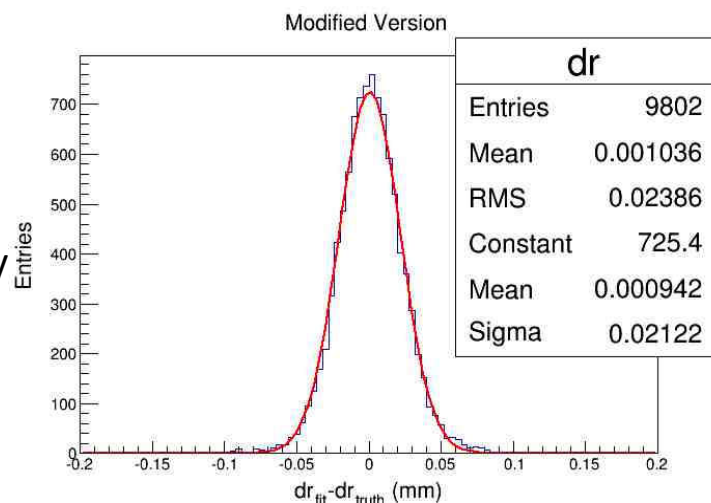
3. Modify [KalFitAlg/src/KalFitReadGdml.cxx](#) to read new GDML file correctly

Fitting Result (1Gev/c Muon)

New
Geometry

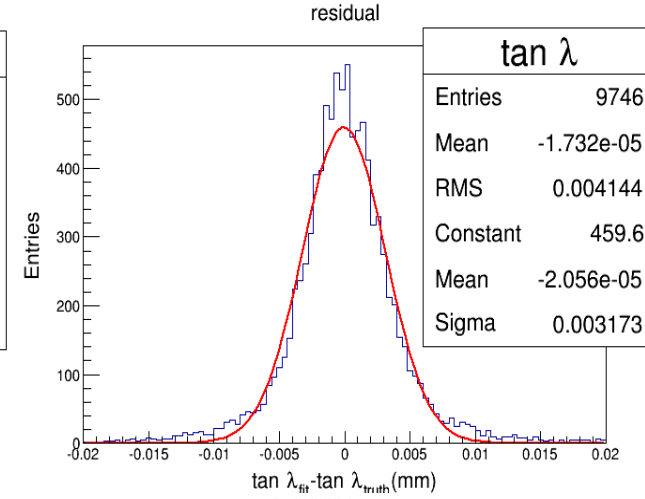
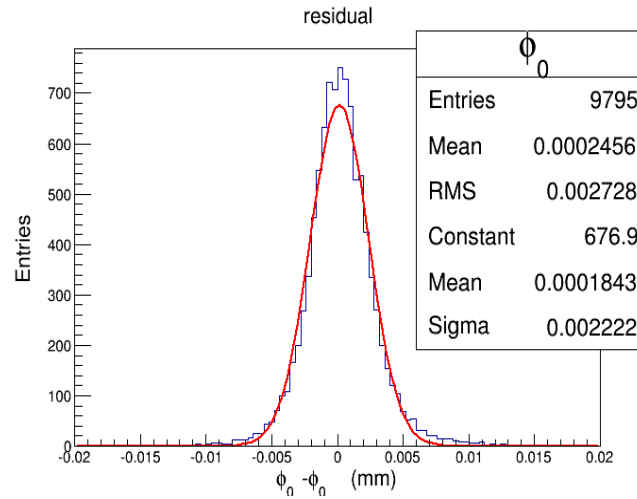
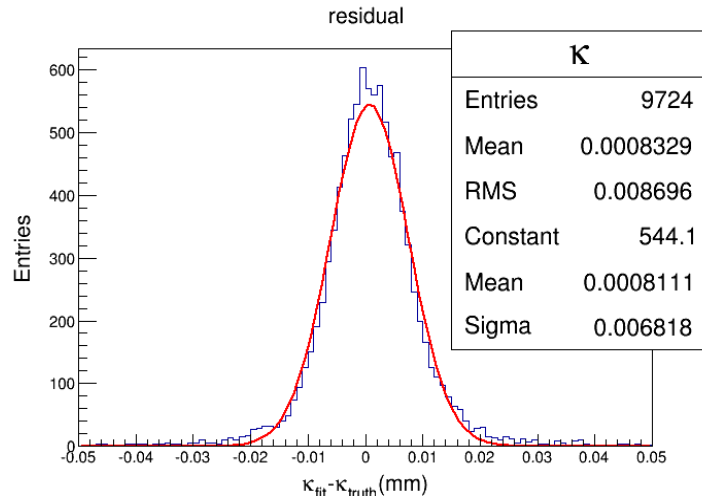


Old
Geometry

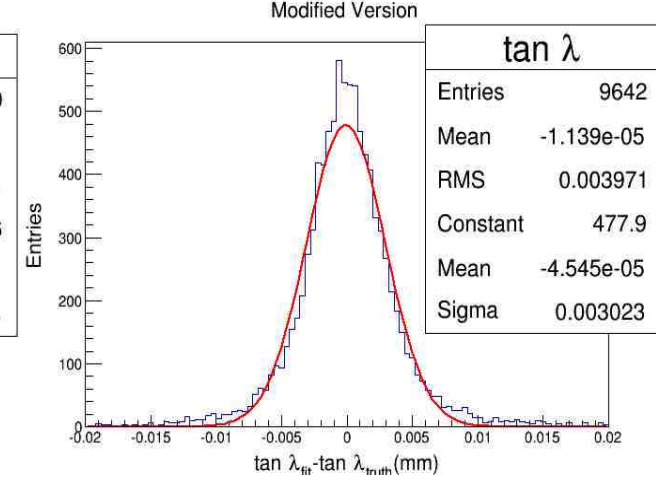
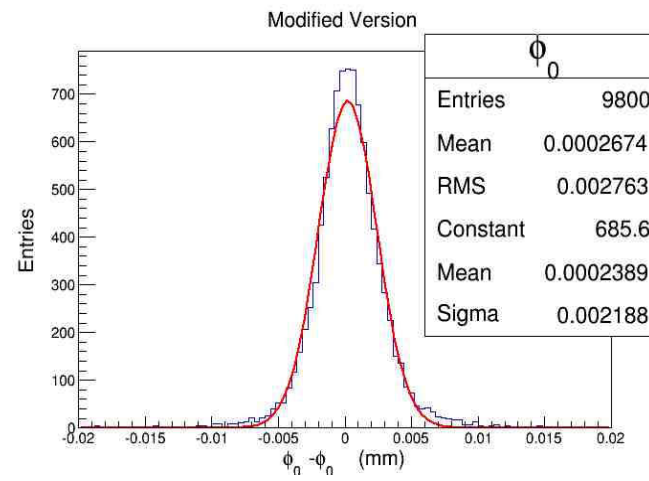
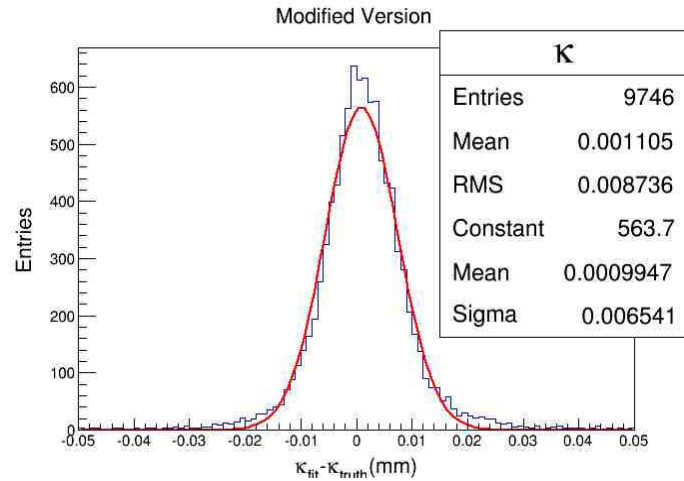


Fitting Result (1Gev/c Muon)

New
Geometry



Old
Geometry



backup

	Layer 1 (L=532 mm)				Layer 2 (L=690 mm)				Layer 3 (L=847 mm)			
	New		Old		New		Old		New		Old	
	R_{in}	R_{out}	R_{in}	R_{out}	R_{in}	R_{out}	R_{in}	R_{out}	R_{in}	R_{out}	R_{in}	R_{out}
Cathode	76.915	79.055	75.234	78.338	121.415	123.555	120.5	123.604	161.915	164.055	163.0	166.104
Gap D	79.055	84.055	78.338	81.338	123.555	128.555	123.604	126.604	164.055	169.055	166.104	169.104
GEM foil	84.055	84.111	81.338	81.392	128.555	128.611	126.604	126.658	169.055	169.111	169.104	169.158
Gap T1	84.111	86.111	81.392	83.392	128.611	130.611	126.658	128.658	169.111	171.111	169.158	171.158
GEM foil	86.111	86.167	83.392	83.446	130.611	130.667	128.658	128.712	171.111	171.167	171.158	171.212
Gap T2	86.167	88.167	83.446	85.446	130.667	132.667	128.712	130.712	171.167	173.167	171.212	173.212
GEM foil	88.167	88.223	85.446	85.5	132.667	132.723	130.712	130.766	173.167	173.223	173.212	173.266
Gap I	88.223	90.223	85.5	87.5	132.723	134.723	130.766	132.766	173.223	175.223	173.266	175.266
Anode	90.223	94.4605	87.5	87.7512	134.723	138.9605	132.766	133.0172	175.223	179.4605	175.266	175.5172
Shield			87.7512	90.8512			133.0172	136.1172			175.5172	178.6172
Separator									182.5	183.5		

Backup (**new** material arrangement of layer 3)

1		material	Ri (cm)	Ro (cm)	T (cm)	X0 (cm)	T/X0 (%)	accumulation	sum T	sum T/X0
2	Separator	CarbonFiber	18.25	18.35	0.1	25.3831	0.393963	0.393963	0.1	0.393963
3	Anode	Kapton	17.941	17.946	0.005	28.5747	0.017498	0.411461	0.01375	0.04811948
4		Cu	17.9405	17.941	0.0005	1.43558	0.0348292	0.44629	0.0015	0.1044876
5		Epoxy	17.939	17.9405	0.0015	33.9598	0.00441699	0.450707	0.0085	0.02502961
6		Rohacell	17.739	17.939	0.2	1378.81	0.0145053	0.465212	0.4	0.0290106
7		Epoxy	17.7375	17.739	0.0015	33.9598	0.00441699	0.469629	0.42375	0.20664729
8		Kapton	17.7363	17.7375	0.00125	28.5747	0.00437449	0.474004		
9		Epoxy	17.7348	17.7363	0.0015	33.9598	0.00441699	0.478421		
10		Rohacell	17.5348	17.7348	0.2	1378.81	0.0145053	0.492926		
11		Epoxy	17.5333	17.5348	0.0015	33.9598	0.00441699	0.497343		
12		Kapton	17.5308	17.5333	0.0025	28.5747	0.00874899	0.506092		
13		Epoxy	17.5283	17.5308	0.0025	33.9598	0.00736165	0.513454		
14		Cu	17.5278	17.5283	0.0005	1.43558	0.0348292	0.548283		
15		Kapton	17.5228	17.5278	0.005	28.5747	0.017498	0.565781		
16		Cu	17.5223	17.5228	0.0005	1.43558	0.0348292	0.60061		
17										
18	Gap I	Cgemgas	17.3223	17.5223	0.2	13372.4	0.00149562	0.602106		
19	GEM Foil	Cu	17.322	17.3223	0.0003	1.43558	0.0208975	0.623003	0.0006	0.041795
20		Kapton	17.317	17.322	0.005	28.5747	0.017498	0.640501	0.005	0.017498
21		Cu	17.3167	17.317	0.0003	1.43558	0.0208975	0.661399	0.0056	0.059293

Backup (new material arrangement of layer 3)

22	Gap T2	Cgemgas	17.1167	17.3167	0.2	13372.4	0.00149562	0.662894	3 foil	3 foil
23	GEM Foil	Cu	17.1164	17.1167	0.0003	1.43558	0.0208975	0.683792	0.0018	0.125385
24		Kapton	17.1114	17.1164	0.005	28.5747	0.017498	0.70129	0.015	0.052494
25	GaP T1	Cu	17.1111	17.1114	0.0003	1.43558	0.0208975	0.722187		
26		Cgemgas	16.9111	17.1111	0.2	13372.4	0.00149562	0.723683		
27	GEM Foil	Cu	16.9108	16.9111	0.0003	1.43558	0.0208975	0.74458		
28		Kapton	16.9058	16.9108	0.005	28.5747	0.017498	0.762078		
29	Gap D	Cu	16.9055	16.9058	0.0003	1.43558	0.0208975	0.782976		
30		Cgemgas	16.4055	16.9055	0.5	13372.4	0.00373905	0.786715	1.1	0.00822591
31								3 foil sum	0.0168	0.177879
32	Cathode	Cu	16.405	16.4055	0.0005	1.43558	0.0348292	0.821544	0.0005	0.0348292
33		Kapton	16.4	16.405	0.005	28.5747	0.017498	0.839042	0.0075	0.02624698
34		Epoxy	16.3985	16.4	0.0015	33.9598	0.00441699	0.843459	0.006	0.01766796
35		Rohacell	16.2985	16.3985	0.1	1378.81	0.00725264	0.850712	0.2	0.01450528
36		Epoxy	16.297	16.2985	0.0015	33.9598	0.00441699	0.85512	0.214	0.09324942
37		Kapton	16.2957	16.297	0.00125	28.5747	0.00437449	0.859503		
38		Epoxy	16.2942	16.2957	0.0015	33.9598	0.00441699	0.86392		
39		Rohacell	16.1942	16.2942	0.1	1378.81	0.00725264	0.871173		
40		Epoxy	16.1927	16.1942	0.0015	33.9598	0.00441699	0.87559		
41		Kapton	16.1915	16.1927	0.00125	28.5747	0.00437449	0.879964		
42	air between	Air	13.896	16.1915	2.29545	30392.1	0.00755278	0.887517		

Backup (old material arrangement of layer 3)

1		material	Ri (cm)	Ro (cm)	T (cm)	X0 (cm)	T/X0 (%)	accumulation	sum T	sum T/X0
2	Shield	Kapton	17.8567	17.8617	0.005	28.5747	0.017498	0.017498	0.01	0.034996
3		Honeycomb	17.5567	17.8567	0.3	1312.38	0.0228593	0.0403572	0.3	0.0228593
4		Kapton	17.5517	17.5567	0.005	28.5747	0.017498	0.0578552	0.31	0.0578553
5		Au	17.5517	17.5517	0.00001	0.334436	0.0029901	0.0608453	0.00002	0.0059802
6		Cu	17.5515	17.5517	0.0002	1.43558	0.0139317	0.074777	0.0006	0.0417951
7	Anode	Kapton	17.5465	17.5515	0.005	28.5747	0.017498	0.092275	0.0225	0.0787409
8		Epoxy	17.5455	17.5465	0.001	33.9598	0.00294466	0.0952196	0.002	0.00588932
9		Kapton	17.533	17.5455	0.0125	28.5747	0.0437449	0.138965	0.02512	0.13240552
10		Epoxy	17.532	17.533	0.001	33.9598	0.00294466	0.141909		
11		Cu	17.5319	17.532	0.00015	1.43558	0.0104488	0.152358		
12		Kapton	17.5269	17.5319	0.005	28.5747	0.017498	0.169856		
13		Cu	17.5266	17.5269	0.00025	1.43558	0.0174146	0.187271		
14		Au	17.5266	17.5266	0.00001	0.334436	0.0029901	0.190261		
15	Gap I	Cgemgas	17.3266	17.5266	0.2	13372.4	0.00149562	0.191756		
16	GEM Foil	Cu	17.3264	17.3266	0.0002	1.43558	0.0139317	0.205688	0.0004	0.0278634
17		Kapton	17.3214	17.3264	0.005	28.5747	0.017498	0.223186	0.005	0.017498
18		Cu	17.3212	17.3214	0.0002	1.43558	0.0139317	0.237118	0.0054	0.0453614

Backup (old material arrangement of layer 3)

19	Gap T2	Cgemgas	17.1212	17.3212	0.2	13372.4	0.00149562	0.238613	3 foil	3 foil
20		Cu	17.121	17.1212	0.0002	1.43558	0.0139317	0.252545	0.0012	0.0835902
21	GEM Foil	Kapton	17.116	17.121	0.005	28.5747	0.017498	0.270043	0.015	0.052494
22		Cu	17.1158	17.116	0.0002	1.43558	0.0139317	0.283975		
23	GaP T1	Cgemgas	16.9158	17.1158	0.2	13372.4	0.00149562	0.28547		
24		Cu	16.9156	16.9158	0.0002	1.43558	0.0139317	0.299402		
25	GEM Foil	Kapton	16.9106	16.9156	0.005	28.5747	0.017498	0.3169		
26		Cu	16.9104	16.9106	0.0002	1.43558	0.0139317	0.330832		
27	Gap D	Cgemgas	16.6104	16.9104	0.3	13372.4	0.00224343	0.333075	0.9	0.00673029
28								3 foil sum	0.0162	0.1360842
29		Cu	16.6102	16.6104	0.0002	1.43558	0.0139317	0.347007	0.0004	0.0278634
30		Kapton	16.6052	16.6102	0.005	28.5747	0.017498	0.364505	0.01	0.034996
31	Cathode	Honeycomb	16.3052	16.6052	0.3	1312.38	0.0228593	0.387364	0.3	0.0228593
32		Kapton	16.3002	16.3052	0.005	28.5747	0.017498	0.404862	0.3104	0.0857187
33		Cu	16.3	16.3002	0.0002	1.43558	0.0139317	0.418794		
34	between la	Air	13.6117	16.3	2.68828	30392.1	0.00884532	0.427639		