TPC for ILD

DD4HEP

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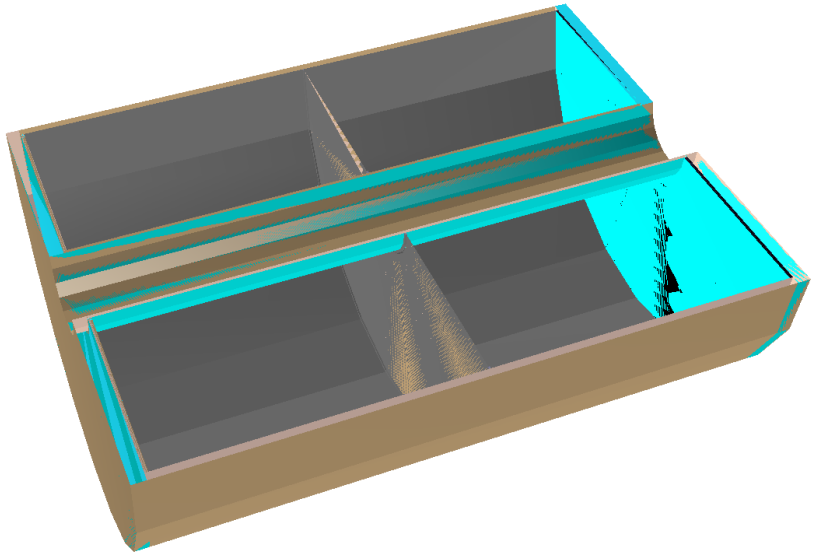
HELMHOLTZ ASSOCIATION

DESY

TPC for ILD simulation

- Checking detector model
  - Dimensions, material budget, pads, reconstruction,...
- Model exported from Mokka (ILD_o1_v5)
- Dimensions
  - Inner radius: 329mm, Outer radius: 1808 mm, half length: 2350 mm
  - Inner wall thickness: 25mm, Outer wall thickness: 60mm
  - Inner and Outer radius of sensitive volume: 384-1718 mm (222 pad rows of 6mm height)



Inner and Outer Walls

```
TPC10: Add Material to Inner Wall: dr =  0.01 mm. Material = G4_Al X0 = 8.8789  0.000112627% X0
TPC10: Add Material to Inner Wall: dr =  0.05 mm. Material = G4_KAPTON X0 = 28.5903  0.000174884% X0
TPC10: Add Material to Inner Wall: dr =   0.3 mm. Material = g10 X0 = 16.1529  0.00185725% X0
TPC10: Add Material to Inner Wall: dr =  24.22 mm. Material = G4_AIR X0 = 30280.2  7.99863e-05% X0
TPC10: Add Material to Inner Wall: dr =   0.3 mm. Material = g10 X0 = 16.1529  0.00185725% X0
TPC10: Add Material to Inner Wall: dr =  0.05 mm. Material = G4_KAPTON X0 = 28.5903  0.000174884% X0
TPC10: Add Material to Inner Wall: dr =  0.07 mm. Material = G4_Cu X0 = 1.43516  0.00487749% X0
TPC10: Inner wall material corresponds to 0.9% of a radiation length.
```

Inner wall

```
TPC10: Add Material to Outer Wall: dr =  0.07 mm. Material = G4_Cu X0 = 1.43516  0.00487749% X0
TPC10: Add Material to Outer Wall: dr =  0.05 mm. Material = G4_KAPTON X0 = 28.5903  0.000174884% X0
TPC10: Add Material to Outer Wall: dr =   0.3 mm. Material = g10 X0 = 16.1529  0.00185725% X0
TPC10: Add Material to Outer Wall: dr =  59.22 mm. Material = G4_AIR X0 = 30280.2  0.000195574% X0
TPC10: Add Material to Outer Wall: dr =   0.3 mm. Material = g10 X0 = 16.1529  0.00185725% X0
TPC10: Add Material to Outer Wall: dr =  0.05 mm. Material = G4_KAPTON X0 = 28.5903  0.000174884% X0
TPC10: Add Material to Outer Wall: dr =  0.01 mm. Material = G4_Al X0 = 8.8789  0.000112627% X0
TPC10: Outer wall material corresponds to 0.9% of a radiation length.
```

Outer wall

- Inner wall in agreement with DBD
- Outer wall is 3% X0 in DBD. Current estimation?
- Need to update accordingly and study effect (eg matching with SET)

Cathode

- Cathode material and dimensions? Currently just “air”
- Cathode support (inner and outer rings) exists

```
Cathode dz = 0.00275
Place cathode +z at 0.001375
Place cathode -z at -0.001375
TPC10: Readout material corresponds to 6.9% of a radiation length.
TPC10: Total Endplate material corresponds to 8.68077% of a radiation length.
 +--------------------------------------------------------------------------------------------------------------------------------------------------
 + Material scan between: x_0 = ( 100.00, 100.00, -10.00) [cm] and x_1 = ( 100.00, 100.00,  10.00) [cm] :
 +--------------------------------------------------------------------------------------------------------------------------------------------------
 |     \   Material          Atomic                  Radiation   Interaction               Path   Integrated  Integrated    Material
 | Num. \  Name          Number/Z   Mass/A  Density    Length       Length    Thickness   Length      X0        Lambda      Endpoint
 | Layer \                         [g/mole] [g/cm3]     [cm]         [cm]         [cm]     [cm]      [cm]       [cm]     (     cm,      cm,      cm)
 +--------------------------------------------------------------------------------------------------------------------------------------------------
 |     1 TDR_gas              17   38.746   0.0017  11539.6342   69059.7950      9.997    10.00    0.000866    0.000145  (    0.00,    0.00,   10.00)
 |     2 G4_AIR                7   14.801   0.0012  30280.1689   66568.7074      0.006    10.00    0.000867    0.000145  (    0.00,    0.00,   10.00)
 |     3 TDR_gas              17   38.746   0.0017  11539.6342   69059.7950      9.997    20.00    0.001733    0.000290  (    0.00,    0.00,   20.00)
 +--------------------------------------------------------------------------------------------------------------------------------------------------
 |     0 Average Material     17   38.733   0.0017  11541.7771   69059.0197     20.000    20.00    0.001733    0.000290  (    0.00,    0.00,   20.00)
 +--------------------------------------------------------------------------------------------------------------------------------------------------
```

- Will cathode be placed at z=0? Efficiency drops at θ=90
- Possible to move by eg 10 cm? Will need to be studied

Endcap

+ Material scan between: x_0 = (100.00, 100.00, 220.00) [cm] and x_1 = (100.00, 100.00, 250.00) [cm] :

Num. \ Layer	Material \ Name	Atomic Number/Z	Mass/A [g/mole]	Density [g/cm3]	Radiation Length [cm]	Interaction Length [cm]	Thickness [cm]	Path Length [cm]	Integrated X0 [cm]	Integrated Lambda [cm]	Material Endpoint (cm,	cm,	cm)
1	TDR_gas	17	38.746	0.0017	11539.6342	69059.7950	2.500	2.50	0.000217	0.000036	(0.00,	0.00,	2.50)
2	G4_Cu	29	63.546	8.9600	1.4352	15.5141	0.000	2.50	0.000426	0.000056	(0.00,	0.00,	2.50)
3	G4_KAPTON	6	12.701	1.4200	28.5903	24.8436	0.003	2.50	0.000531	0.000176	(0.00,	0.00,	2.50)
4	G4_Cu	29	63.546	8.9600	1.4352	15.5141	0.000	2.50	0.000740	0.000196	(0.00,	0.00,	2.50)
5	TDR_gas	17	38.746	0.0017	11539.6342	69059.7950	0.445	2.95	0.000778	0.000202	(0.00,	0.00,	2.95)
6	G4_Cu	29	63.546	8.9600	1.4352	15.5141	0.000	2.95	0.000987	0.000221	(0.00,	0.00,	2.95)
7	G4_KAPTON	6	12.701	1.4200	28.5903	24.8436	0.003	2.95	0.001092	0.000342	(0.00,	0.00,	2.95)
8	G4_Cu	29	63.546	8.9600	1.4352	15.5141	0.000	2.95	0.001301	0.000362	(0.00,	0.00,	2.95)
9	TDR_gas	17	38.746	0.0017	11539.6342	69059.7950	0.445	3.40	0.001340	0.000368	(0.00,	0.00,	3.40)
10	G4_Cu	29	63.546	8.9600	1.4352	15.5141	0.000	3.40	0.001549	0.000387	(0.00,	0.00,	3.40)
11	G4_KAPTON	6	12.701	1.4200	28.5903	24.8436	0.003	3.40	0.001654	0.000508	(0.00,	0.00,	3.40)
12	G4_Cu	29	63.546	8.9600	1.4352	15.5141	0.000	3.40	0.001863	0.000527	(0.00,	0.00,	3.40)
13	TDR_gas	17	38.746	0.0017	11539.6342	69059.7950	0.445	3.84	0.001901	0.000534	(0.00,	0.00,	3.84)
14	G4_Cu	29	63.546	8.9600	1.4352	15.5141	0.005	3.85	0.005385	0.000856	(0.00,	0.00,	3.85)
15	g10	11	21.318	1.7000	16.1529	68.2164	0.200	4.05	0.017767	0.003788	(0.00,	0.00,	4.05)
16	G4_Si	14	28.085	2.3300	9.3496	45.7532	0.050	4.10	0.023115	0.004881	(0.00,	0.00,	4.10)
17	epoxy	6	11.888	1.3000	32.2936	27.1368	0.200	4.30	0.029308	0.012251	(0.00,	0.00,	4.30)
18	G4_KAPTON	6	12.701	1.4200	28.5903	24.8436	0.100	4.40	0.032806	0.016276	(0.00,	0.00,	4.40)
19	G4_Al	13	26.982	2.6990	8.8789	38.8766	0.200	4.60	0.055331	0.021420	(0.00,	0.00,	4.60)
20	G4_KAPTON	6	12.701	1.4200	28.5903	24.8436	0.100	4.70	0.058829	0.025446	(0.00,	0.00,	4.70)
21	CarbonFiber	6	11.956	1.4667	28.8192	54.6827	0.300	5.00	0.069238	0.030932	(0.00,	0.00,	5.00)
22	TDR_gas	17	38.746	0.0017	11539.6342	69059.7950	0.000	5.00	0.069238	0.030932	(0.00,	0.00,	5.00)
23	TPC_endplate_mix	9	17.288	0.5828	56.2236	137.6252	10.000	15.00	0.247099	0.103593	(0.00,	0.00,	15.00)
24	Air	7	14.801	0.0012	30280.1689	66568.7074	15.000	30.00	0.247595	0.103818	(0.00,	0.00,	30.00)
0	Average Material	8	17.129	0.2635	121.1657	288.9664	30.000	30.00	0.247595	0.103818	(0.00,	0.00,	30.00)

Readout + endplate material
in accordance with DBD

Summary

- TPC model not fully up to date. Update?
  - Outer wall?
  - Cathode?

- Need to propagate findings and solutions to the software group

Back-Up

```
TPC10: Total Gas material corresponds to 0.120801% of a radiation length.
TPC10: Add Material to Inner Wall: dr =  0.01 mm. Material = G4_Al X0 = 8.8789  0.000112627% X0
TPC10: Add Material to Inner Wall: dr =  0.05 mm. Material = G4_KAPTON X0 = 28.5903  0.000174884% X0
TPC10: Add Material to Inner Wall: dr =   0.3 mm. Material = g10 X0 = 16.1529  0.00185725% X0
TPC10: Add Material to Inner Wall: dr =  24.22 mm. Material = G4_AIR X0 = 30280.2  7.99863e-05% X0
TPC10: Add Material to Inner Wall: dr =   0.3 mm. Material = g10 X0 = 16.1529  0.00185725% X0
TPC10: Add Material to Inner Wall: dr =  0.05 mm. Material = G4_KAPTON X0 = 28.5903  0.000174884% X0
TPC10: Add Material to Inner Wall: dr =  0.07 mm. Material = G4_Cu X0 = 1.43516  0.00487749% X0
TPC10: Inner wall material corresponds to 0.9% of a radiation length.
TPC10: Inner wall effective X0 = 273.692
TPC10: Add Material to Outer Wall: dr =  0.07 mm. Material = G4_Cu X0 = 1.43516  0.00487749% X0
TPC10: Add Material to Outer Wall: dr =  0.05 mm. Material = G4_KAPTON X0 = 28.5903  0.000174884% X0
TPC10: Add Material to Outer Wall: dr =   0.3 mm. Material = g10 X0 = 16.1529  0.00185725% X0
TPC10: Add Material to Outer Wall: dr =  59.22 mm. Material = G4_AIR X0 = 30280.2  0.000195574% X0
TPC10: Add Material to Outer Wall: dr =   0.3 mm. Material = g10 X0 = 16.1529  0.00185725% X0
TPC10: Add Material to Outer Wall: dr =  0.05 mm. Material = G4_KAPTON X0 = 28.5903  0.000174884% X0
TPC10: Add Material to Outer Wall: dr =  0.01 mm. Material = G4_Al X0 = 8.8789  0.000112627% X0
TPC10: Outer wall material corresponds to 0.9% of a radiation length.
TPC10: Outer wall effective X0 = 648.652
Cathode dz = 0.00275
Place cathode +z at 0.001375
Place cathode -z at -0.001375
TPC10: Readout material corresponds to 6.9% of a radiation length.
TPC10: Total Endplate material corresponds to 8.68077% of a radiation length.
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 + Material scan between: x_0 = (  30.00,   0.00,  50.00) [cm] and x_1 = (  40.00,   0.00,  50.00) [cm] :
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 |     \   Material          Atomic                  Radiation   Interaction              Path   Integrated  Integrated    Material
 | Num. \  Name          Number/Z   Mass/A  Density    Length       Length    Thickness   Length       X0        Lambda      Endpoint
 | Layer \                         [g/mole] [g/cm3]     [cm]         [cm]         [cm]     [cm]      [cm]        [cm]     (     cm,     cm,     cm)
 +-------------------------------------------------------------------------------------------------------------------------------------------------
 |     1 Air                  7   14.801   0.0012  30280.1689   66568.7074      2.900     2.90    0.000096    0.000044  (   2.90,   0.00,   0.00)
 |     2 G4_Al               13   26.982   2.6990      8.8789      38.8766      0.001     2.90    0.000208    0.000069  (   2.90,   0.00,   0.00)
 |     3 G4_KAPTON            6   12.701   1.4200     28.5903      24.8436      0.005     2.91    0.000383    0.000271  (   2.91,   0.00,   0.00)
 |     4 g10                 11   21.318   1.7000     16.1529      68.2164      0.030     2.94    0.002241    0.000710  (   2.94,   0.00,   0.00)
 |     5 G4_AIR               7   14.801   0.0012  30280.1689   66568.7074      2.422     5.36    0.002321    0.000747  (   5.36,   0.00,   0.00)
 |     6 g10                 11   21.318   1.7000     16.1529      68.2164      0.030     5.39    0.004178    0.001186  (   5.39,   0.00,   0.00)
 |     7 G4_KAPTON            6   12.701   1.4200     28.5903      24.8436      0.005     5.39    0.004353    0.001388  (   5.39,   0.00,   0.00)
 |     8 G4_Cu               29   63.546   8.9600      1.4352      15.5141      0.007     5.40    0.009230    0.001839  (   5.40,   0.00,   0.00)
 |     9 TDR_gas             17   38.746   0.0017  11539.6342   69059.7950      3.000     8.40    0.009490    0.001882  (   8.40,   0.00,   0.00)
 |    10 TDR_gas             17   38.746   0.0017  11539.6342   69059.7950      0.300     8.70    0.009516    0.001887  (   8.70,   0.00,   0.00)
 |    11 TDR_gas             17   38.746   0.0017  11539.6342   69059.7950      0.300     9.00    0.009542    0.001891  (   9.00,   0.00,   0.00)
 |    12 TDR_gas             17   38.746   0.0017  11539.6342   69059.7950      0.300     9.30    0.009568    0.001895  (   9.30,   0.00,   0.00)
 |    13 TDR_gas             17   38.746   0.0017  11539.6342   69059.7950      0.300     9.60    0.009594    0.001900  (   9.60,   0.00,   0.00)
 |    14 TDR_gas             17   38.746   0.0017  11539.6342   69059.7950      0.300     9.90    0.009620    0.001904  (   9.90,   0.00,   0.00)
 |    15 TDR_gas             17   38.746   0.0017  11539.6342   69059.7950      0.100    10.00    0.009629    0.001906  (  10.00,   0.00,   0.00)
 +-------------------------------------------------------------------------------------------------------------------------------------------------
 |     0 Average Material    12   25.693   0.0196   1038.5549    5247.8213     10.000    10.00    0.009629    0.001906  (  10.00,   0.00,   0.00)
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