SDHCAL Simulation Updates/Validation

SDHCAL geometry updates

Validation v01-19-05-pre04

Summary

Tibor Kurča
Institut de Physique Nucléaire de Lyon

SDHCAL Simulation Updates

- ***Hcal_EndcapRing_SD_v01:***
  - in xml-file removed 1st comment line before <lccdd> tag
    <comment>Calorimeters</comment>
    ….was reason why not seen in ILD_l2_v02 models …
  - layers aligned to the backward part of the detector
  - remaining 2.33 cm free space at Z_min filled by air
- ***hcal_defs.xml :***
  thickness of backplate reduced from 15mm to 10mm
  <constant name="HcalSD_back_plate_thickness"value="10*mm"/>
  → gain of 1 layer in Hcal_Endcaps_SD , now 47/48 design
- ***Hcal_Endcaps_SD_v01 :***
  inner full box cut off (done already in July)
- ***ILD_l6_v02, ILD_s6_v02*** – new models w/SDHCAL TESLA geometry

Hcal_EndcapRing_SD_v01

Material scan Start … End

+ Material scan between: x_0 = (10.00, 250.00, 241.18) [cm] and x_1 = (10.00, 250.00, 263.50) [cm] :

\ Material / Num.\ Name / Layer \	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]
1 Air	7	14.801	0.0012	30280.1689	66568.7074	**2.332**	2.33	0.000077	0.000035
2 Steel304L	26	55.400	8.0000	1.7387	16.6918	**1.500**	3.83	0.862811	0.089900
3 Air	7	14.801	0.0012	30280.1689	66568.7074	0.050	3.88	0.862813	0.089900
4 Steel304L	26	55.400	8.0000	1.7387	16.6918	0.250	4.13	1.006602	0.104878
5 epoxy	6	11.888	1.3000	32.2936	27.1368	0.160	4.29	1.011557	0.110774
6 PCB	10	20.338	1.7000	17.5408	62.7088	0.120	4.41	1.018398	0.112687
7 mylar	6	12.877	1.4000	28.6372	62.9936	0.005	4.42	1.018573	0.112767
.....									
92 graphite	6	12.011	2.2100	19.2292	36.2902	0.005	20.70	8.102039	0.913012
93 FloatGlass	11	22.599	2.4900	10.5252	35.4181	0.070	20.77	8.108690	0.914988
94 RPCGAS2	8	16.746	0.0045	7904.9753	20798.6753	0.120	20.89	8.108705	0.914994
95 FloatGlass	11	22.599	2.4900	10.5252	35.4181	0.110	21.00	8.119156	0.918100
96 graphite	6	12.011	2.2100	19.2292	36.2902	0.005	21.00	8.119416	0.918237
97 mylar	6	12.877	1.4000	28.6372	62.9936	0.018	21.02	8.120027	0.918515
98 Steel304L	26	55.400	8.0000	1.7387	16.6918	0.250	21.27	8.263816	0.933493
99 Air	7	14.801	0.0012	30280.1689	66568.7074	0.050	21.32	8.263818	0.933493
100 Steel304L	26	55.400	8.0000	1.7387	16.6918	**1.000**	22.32	8.838974	0.993403
0 Average Material	23	50.000	5.6633	2.5252	22.4682	22.320	22.32	8.838974	0.993403

SDHCAL Models

SDHCAL technology in 2 models/geometries :

VIDEAU	TESLA - new !
ILD_l2_v02/ILD_l2_v02.xml	ILD_l6_v02/ILD_l6_v02.xml
ILD_s2_v02/ILD_s2_v02.xml	ILD_s6_v02/ILD_s6_v02.xml

1. VIDEAU geometry

ILD/compact/ILD_common_v02/Hcal_Barrel_SD_v01.xml
Hcal_Endcaps_SD_v01.xml
Hcal_EndcapRing_SD_v01.xml

2. TESLA geometry

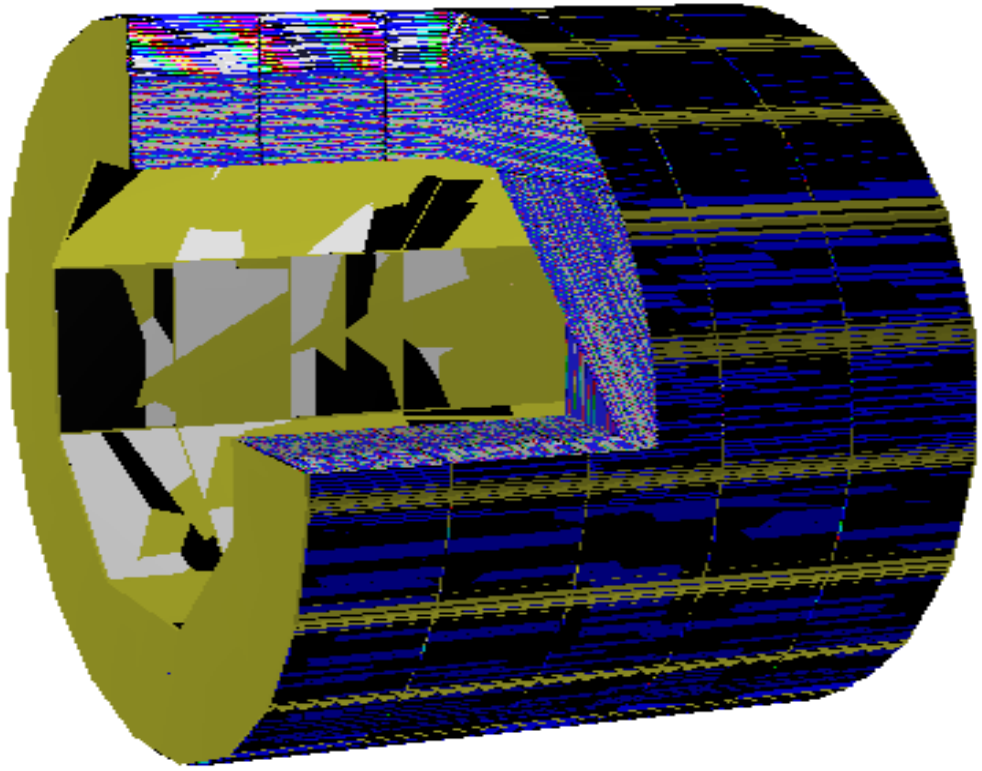
ILD/compact/ILD_common_v02/Hcal_Barrel_SD_v02.xml
Hcal_Endcaps_SD_v02.xml
Hcal_Endcaps_SD_v02_SMALL.xml
Hcal_EndcapRing_SD_v01.xml

Hcal_Barrel_SD_v01

Detailed layer structure :

Videau geometry : ***8 staves (x,y) , 5 modules (z)***

→ corresponding to engineering design

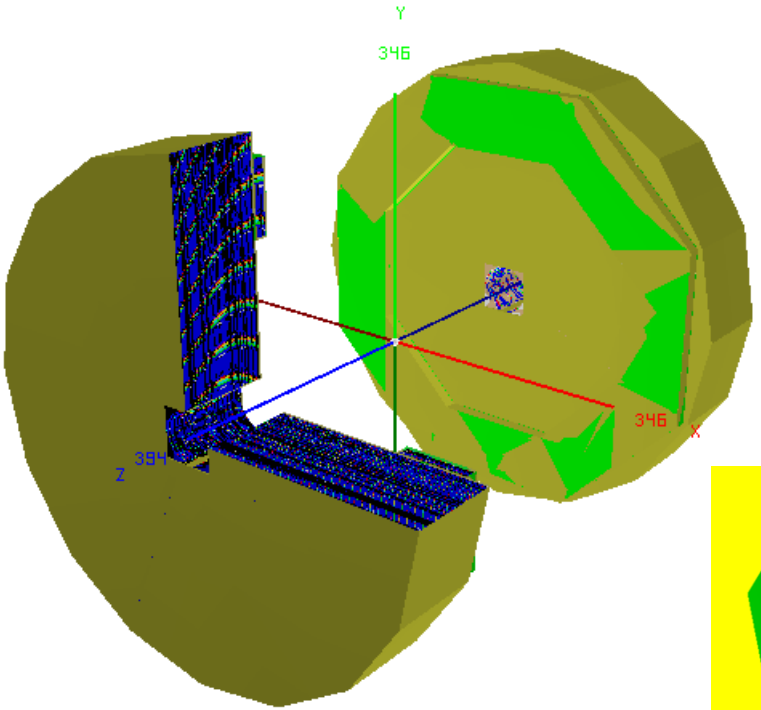


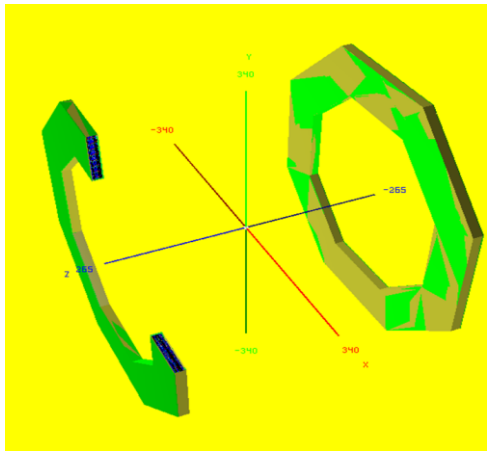
Hcal_Endcaps_SD_v01
Hcal_EndcapRing_SD_v01

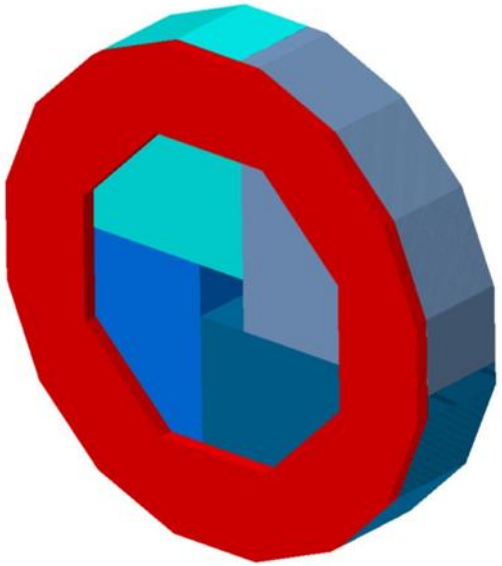
- close to engineering design

- whole volume filled SDHCAL layers
- 4 staves (x,y)
- 47/48 resp. 7/7 layers
- EcRing symmetry 8/16

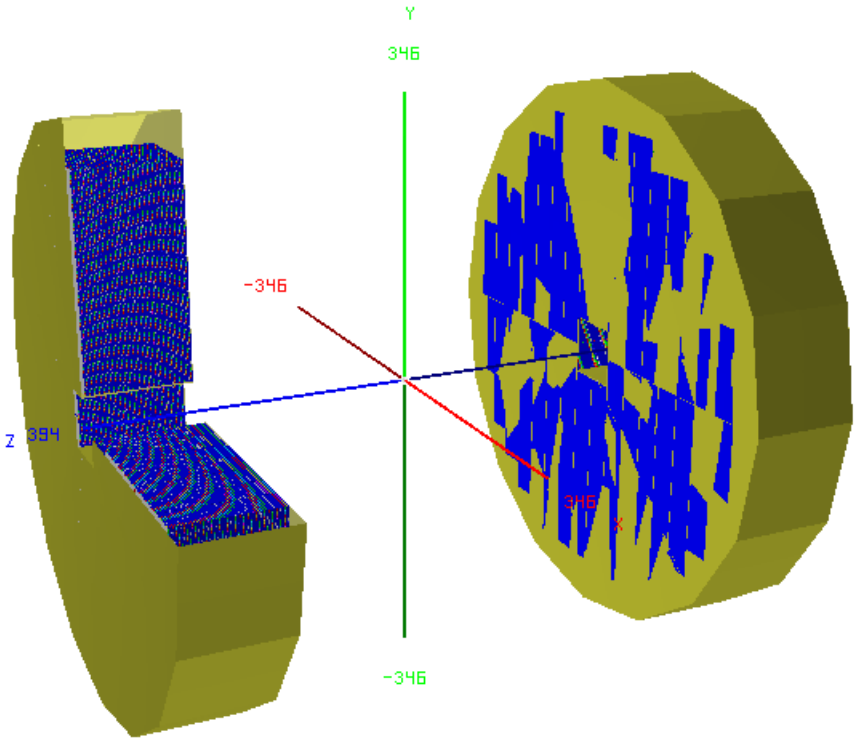
Size: l2 resp s2 version
scaling down (ok)







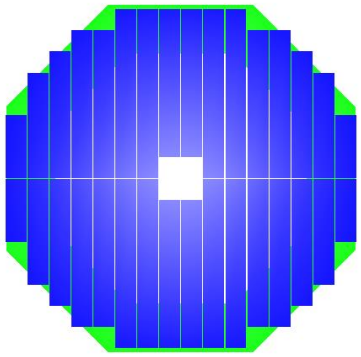
Hcal_Endcaps_SD_v02

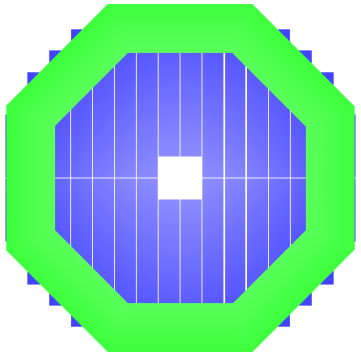


- SDHcal layer structure
- analog of the SHcalSC04 version
- 4 staves (x,y) (not 2)
- layers 47/48
- with boxes (towers)

not enginnering design

ILD_l6_v02





Geometry Test/Validation

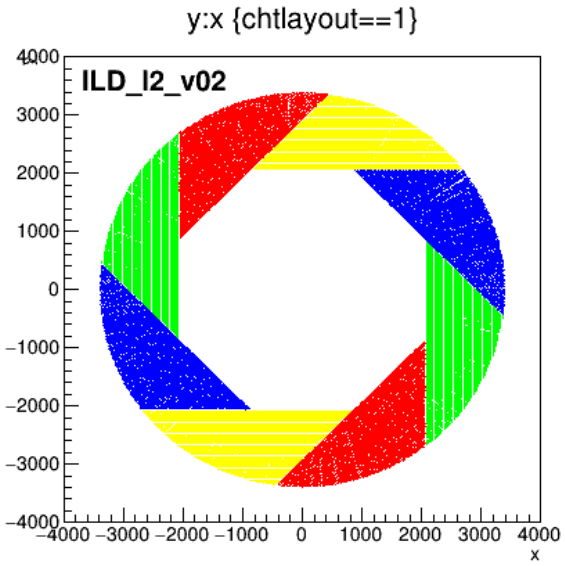
Single muons: 60 GeV, full theta, phi random
- particle gun from the detector center
- DDSim and MarlinReco **v01-19-05-pre04**

SimDigital.cc : see G.Garillot's contribution previous meeting

Analysis:
- root tuples with calorimeter hits, Geant4 steps position, channel indices
- cell middle position of each step contributing to the hit is stored
- determine position zero corresponding to I,J,layer = 0
- calculate: **(hit position-position zero)/I(J,layer)**
  →should peak at cell-, layer-size (separation) 10.406, 27.125 mm

ILD_l2_v02

Y:X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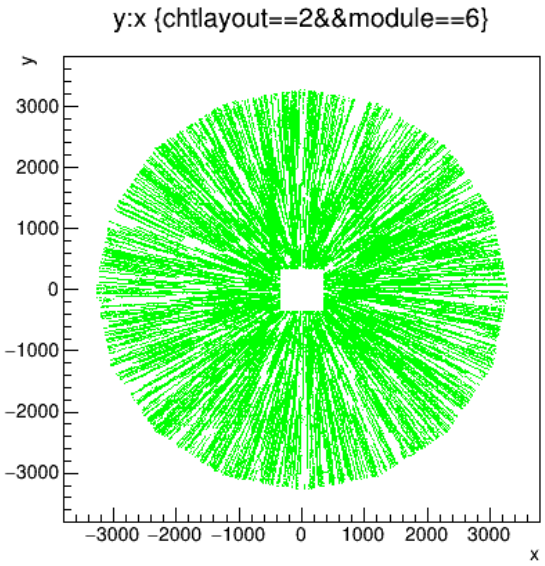
ILD_l2_v02
4000
3000
2000
1000
0
−1000
−2000
−3000
−4000
−4000 −3000 −2000 −1000 0 1000 2000 3000 4000
x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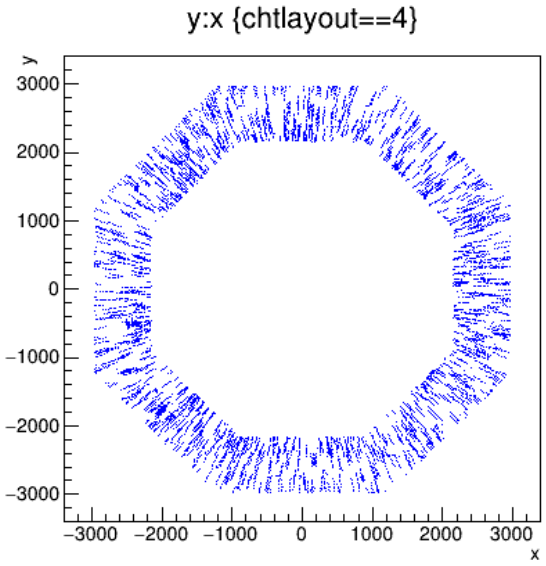
y
3000
2000
1000
0
−1000
−2000
−3000
−3000 −2000 −1000 0 1000 2000 3000
x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y
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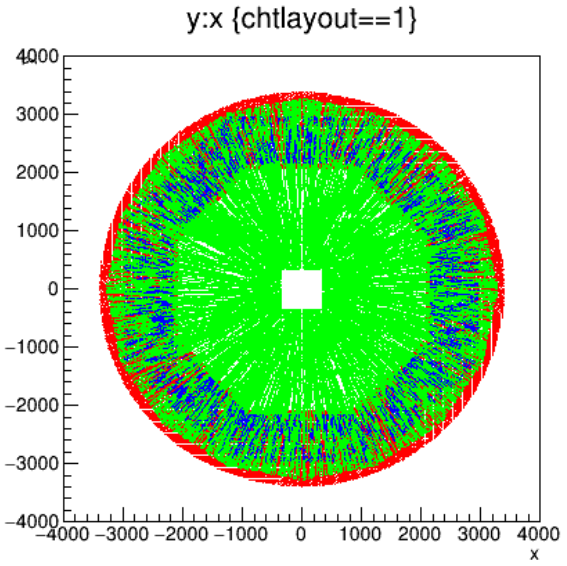
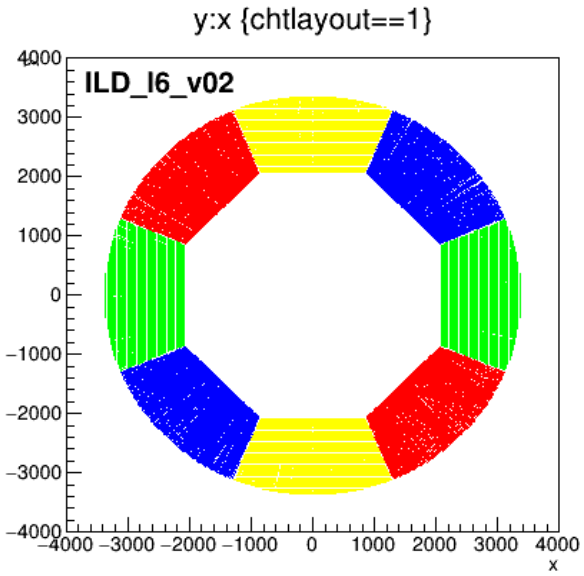
2000
1000
0
−1000
−2000
−3000
−3000 −2000 −1000 0 1000 2000 3000
x


y:x {chtlayout==1}
4000
3000
2000
1000
0
−1000
−2000
−3000
−4000
−4000 −3000 −2000 −1000 0 1000 2000 3000 4000
x

ILD_l6_v02

Y:X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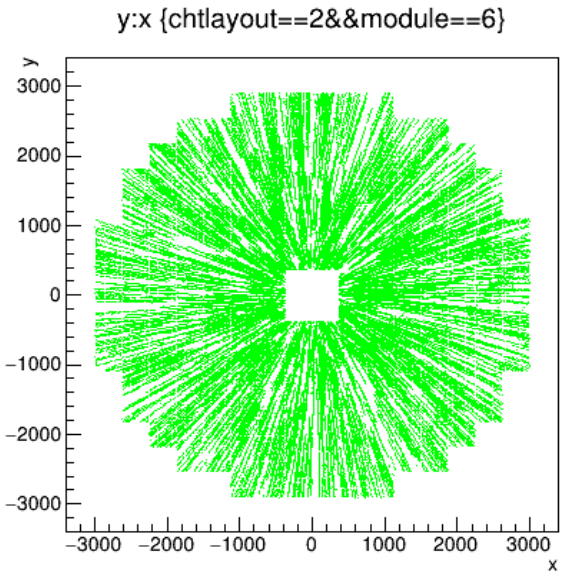
ILD_l6_v02
x
y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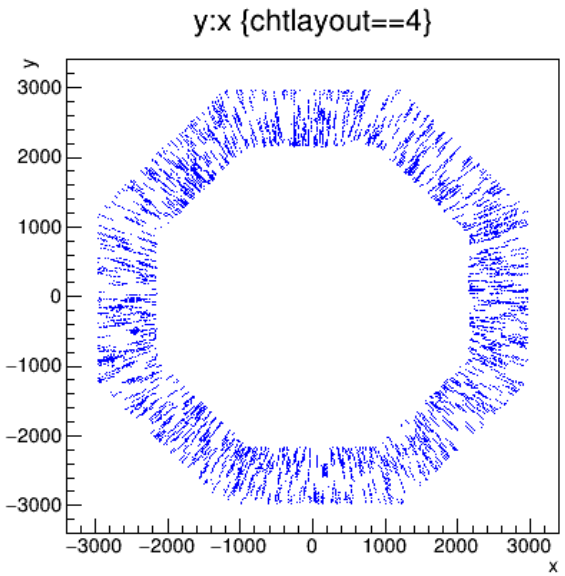
x
y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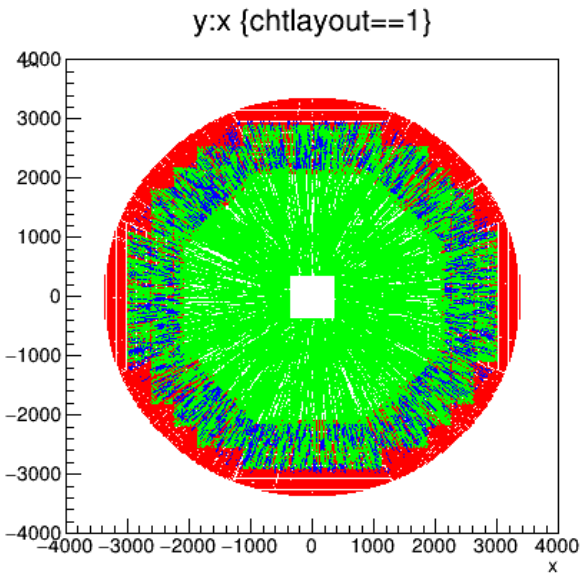
y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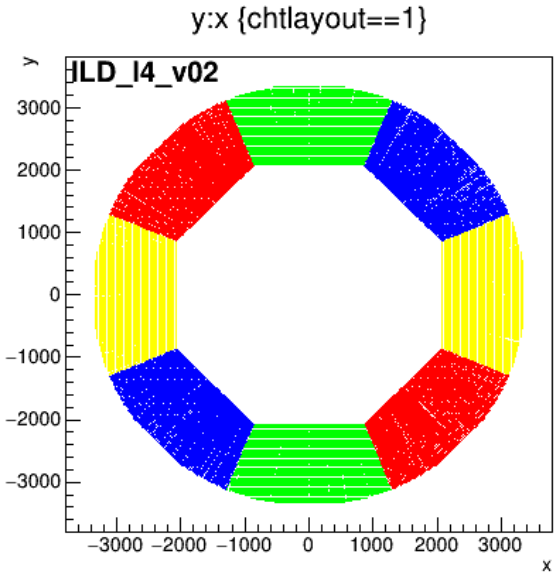
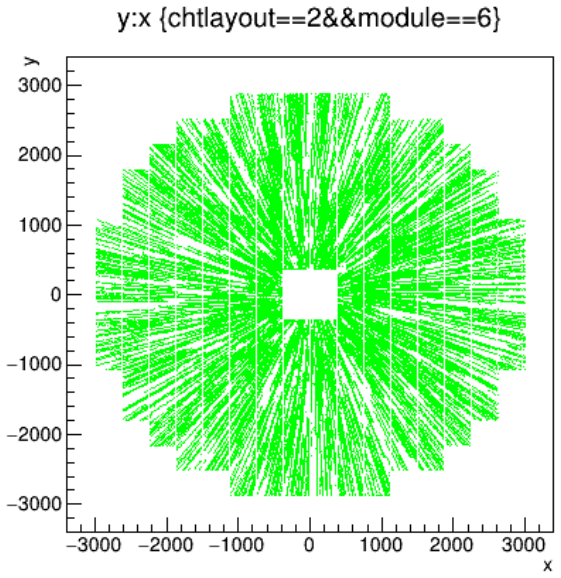
x
y

ILD_l4_v02

Y:X


y:x {chtlayout==1}
ILD_l4_v02
y
x
3000
2000
1000
0
−1000
−2000
−3000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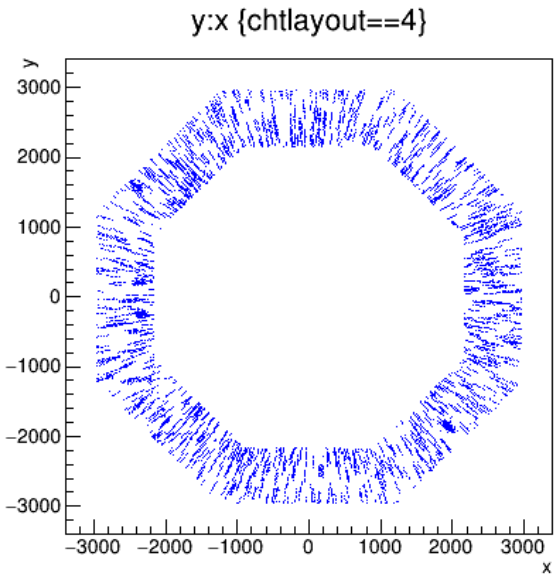
y
x
3000
2000
1000
0
−1000
−2000
−3000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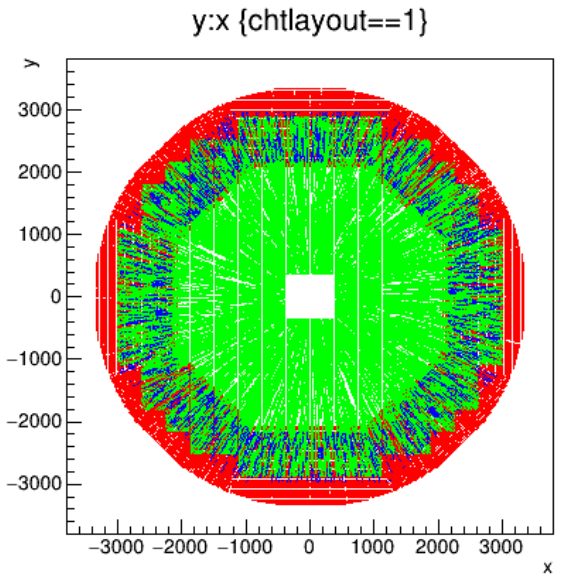
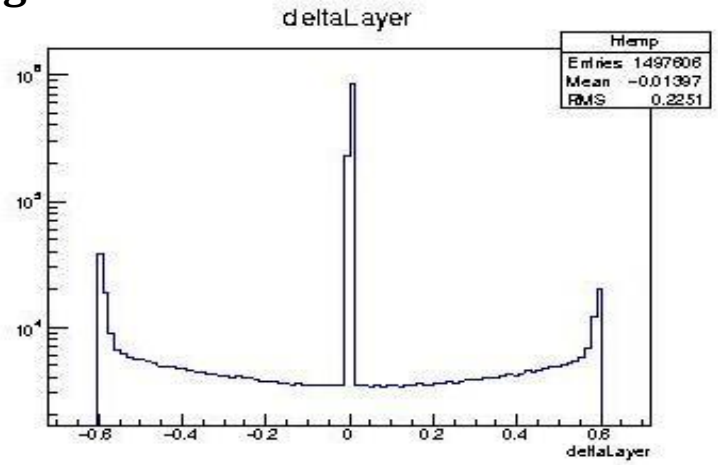
y
x
3000
2000
1000
0
−1000
−2000
−3000


y:x {chtlayout==1}
y
x
3000
2000
1000
0
−1000
−2000
−3000

GEANT4 steps correspond to the cell size

Range +-0.6mm



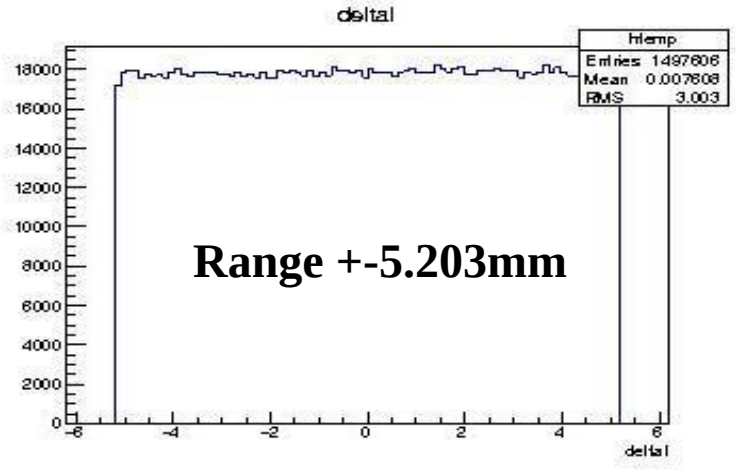
compare step with hit position in 3 directions: layer,I,J

Barrel : layer (y), I(x), J(z)

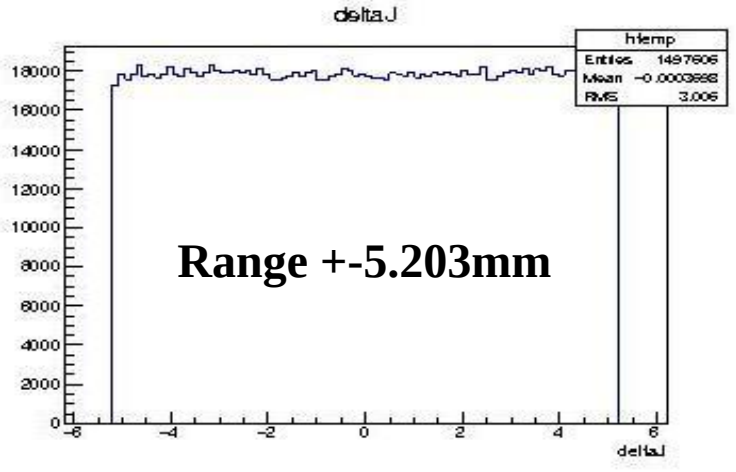
Endcap,Ring : layer(z), I(x), J(y)

layer : gas slice thickness 1.2 mm

I,J : readout pad size 10.406 mm



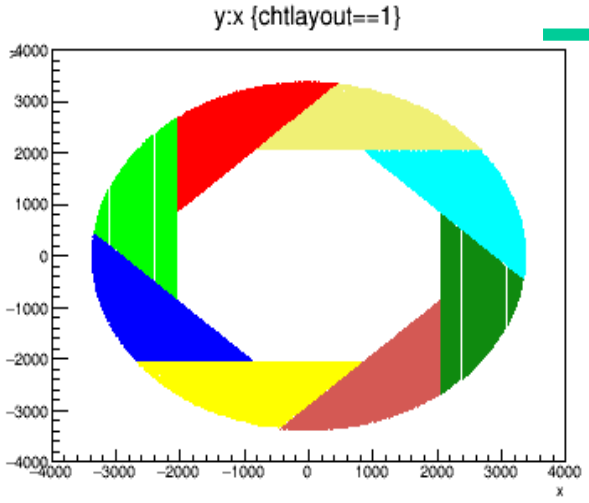
Range +-5.203mm

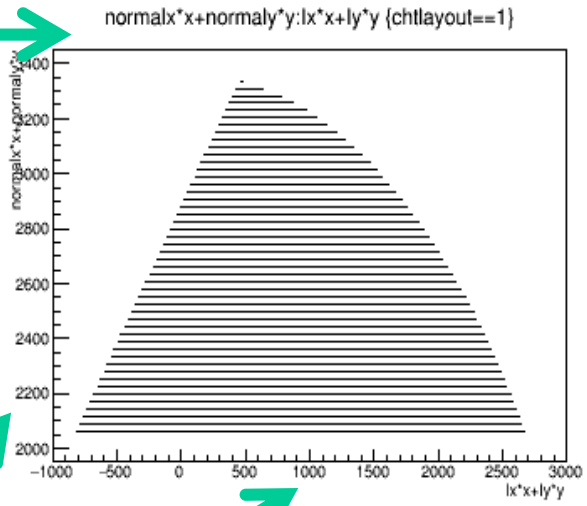


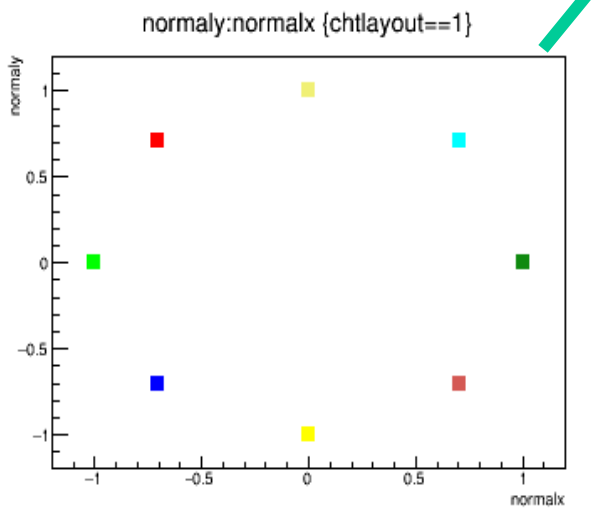
Range +-5.203mm

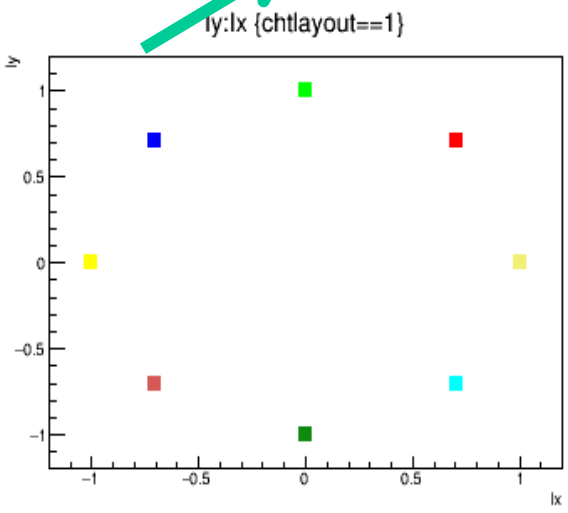
ILD_l2_v02: Hcal_Barrel_SD_v01

y:x projections







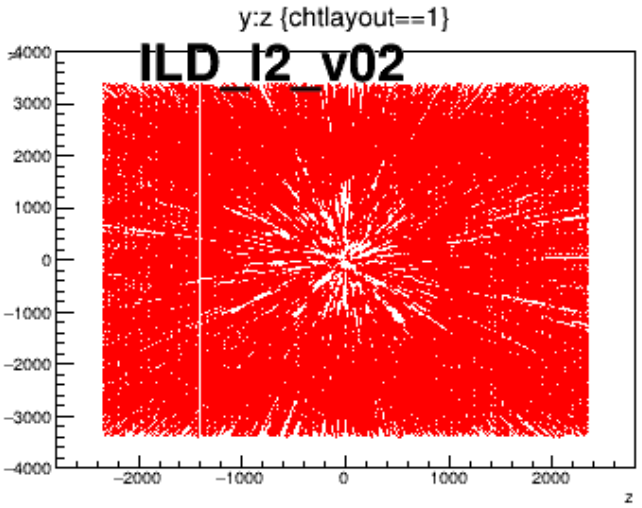


Hits projection of 8 staves

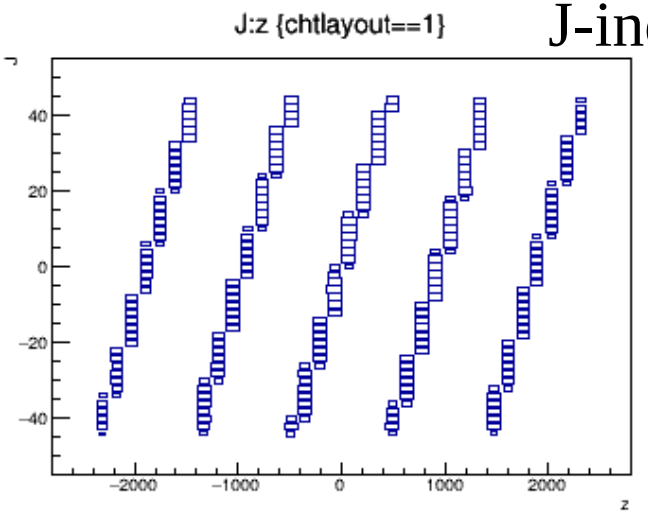
corresponding transormation parameters from SimDigital.cc

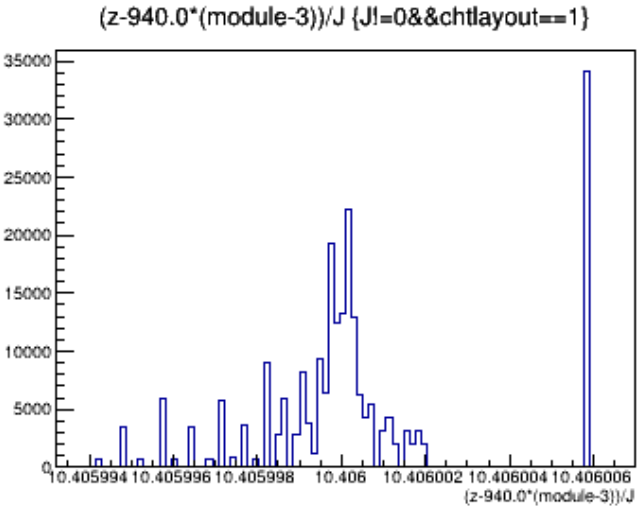
ILD_l2_v02 : Hcal_Barrel_SD_v01

Y : Z



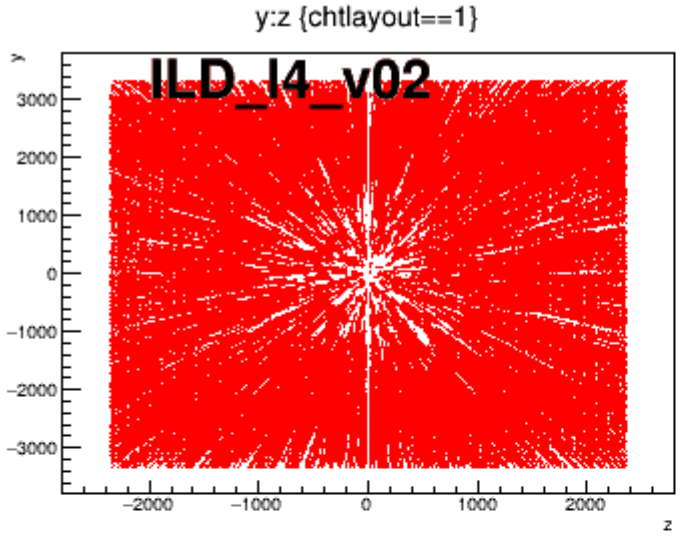
J-index : Z

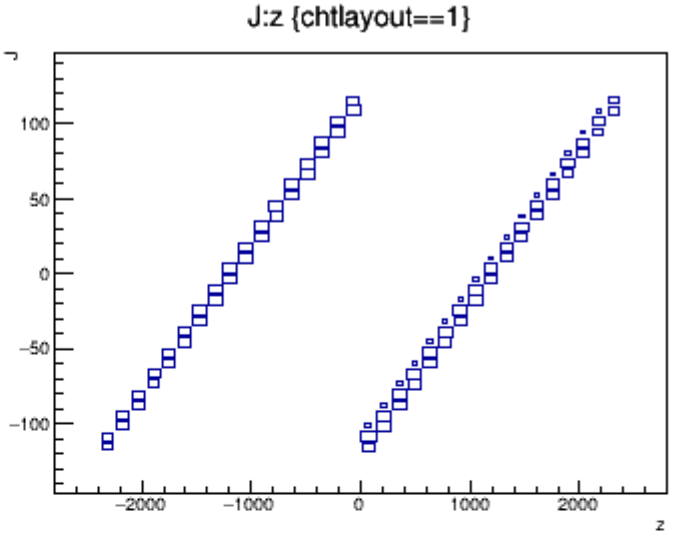


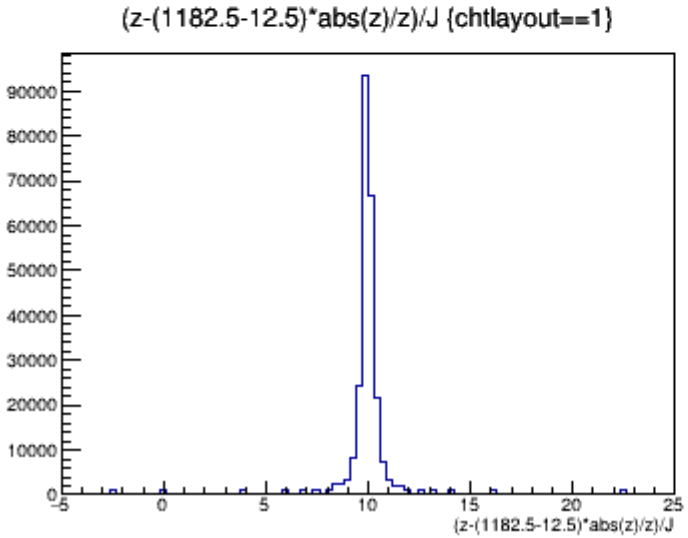


5 modules in z-direction
Linear mapping: channel # z_coordinate
→ Hits at expected positions

ILD_l4_v02 : Barrel





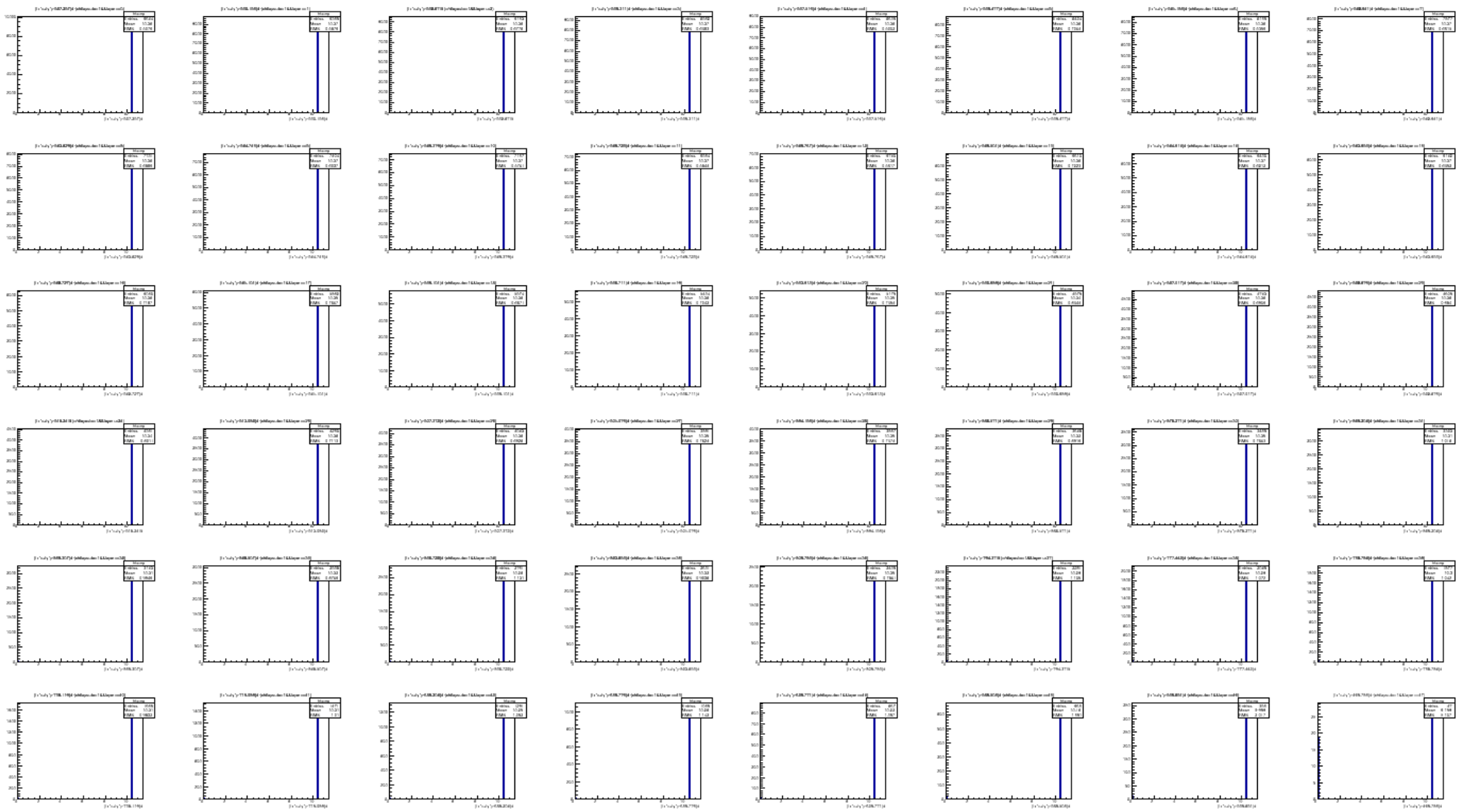


2 modules in Z : layers indexes

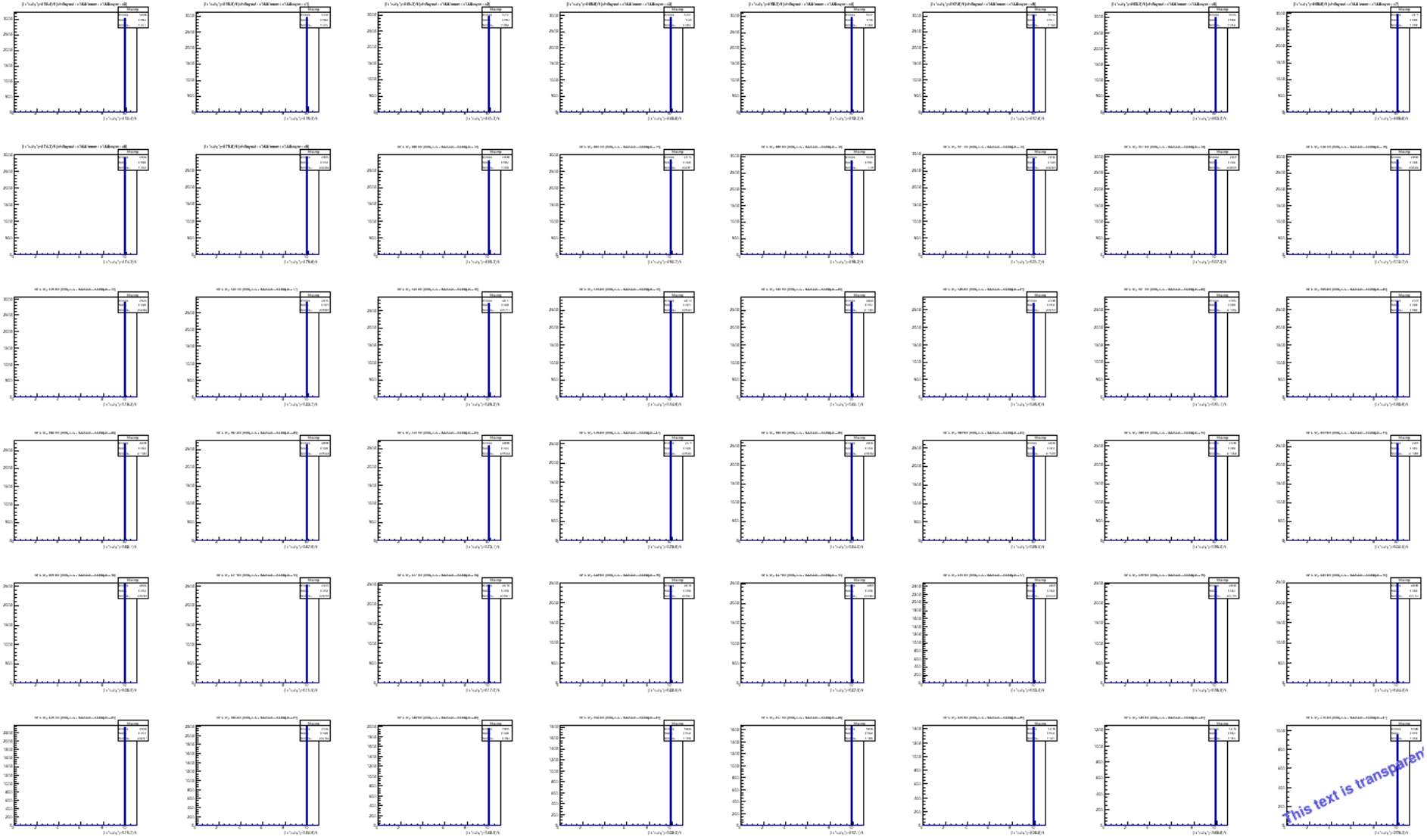
Z-resolution

Hcal_Barrel_SD_v01

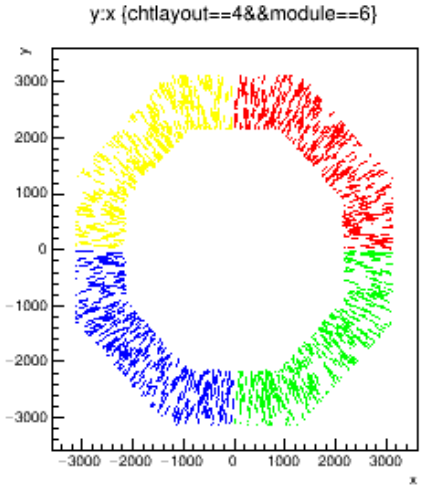
x-resolution all 48 layers

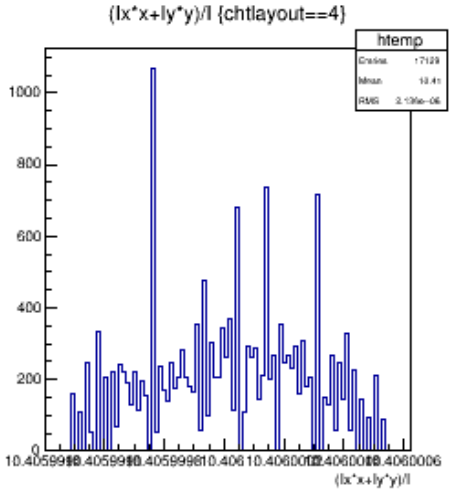


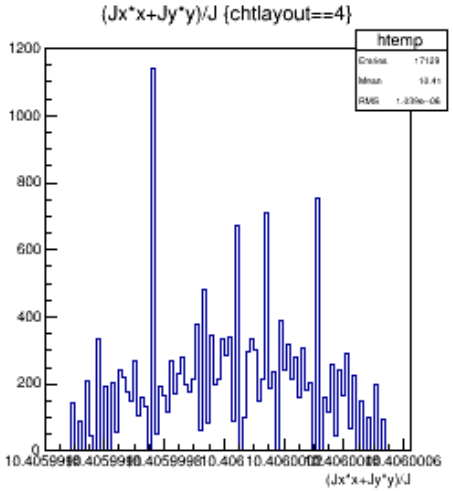
ILD_l4_v02 Barrel 48 layers x-resolution

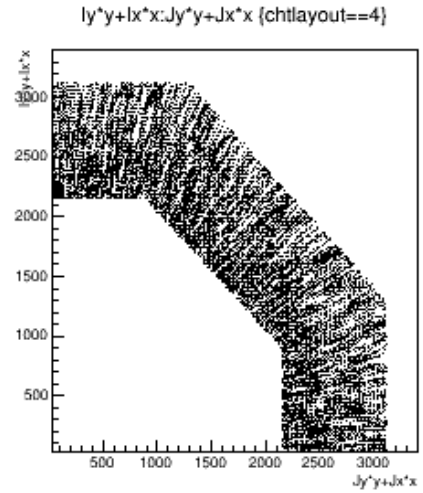


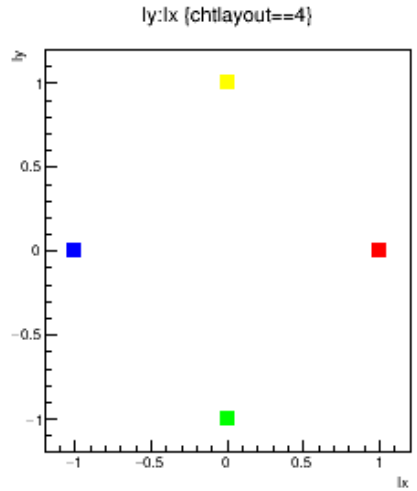
Hcal_EndcapRing_SD_v01

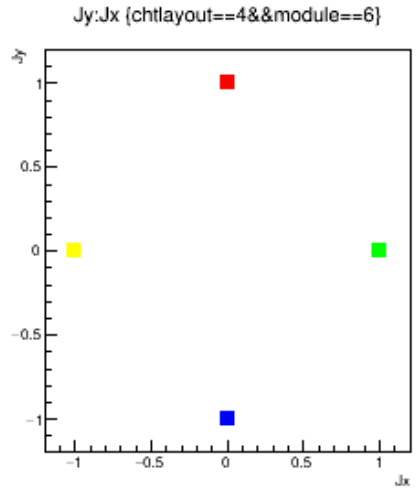








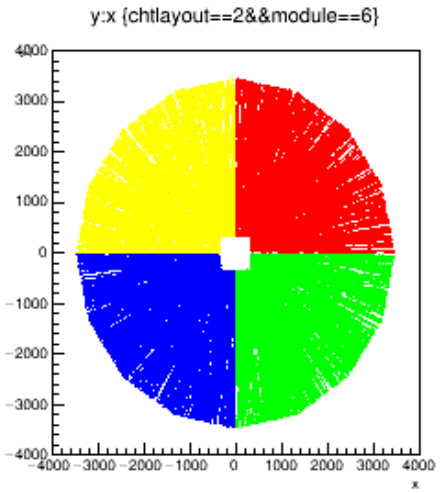


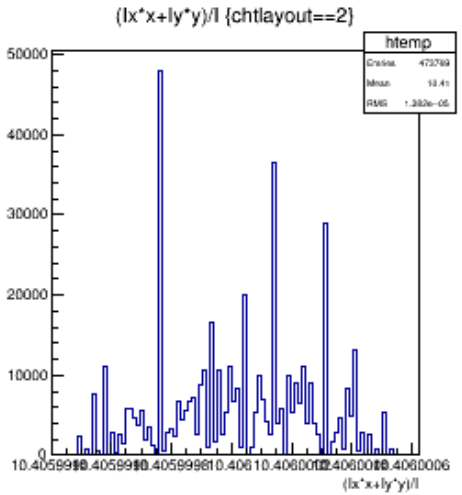


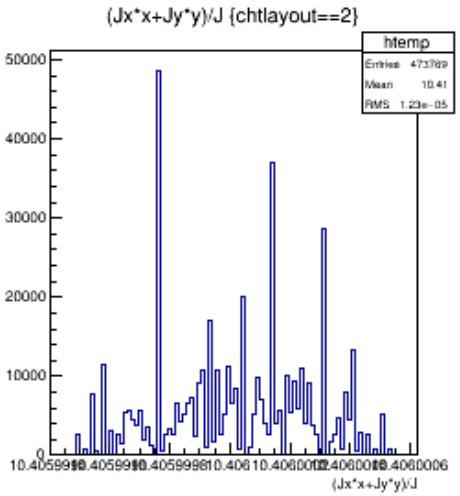
X,Y- resolutions:
pads directions

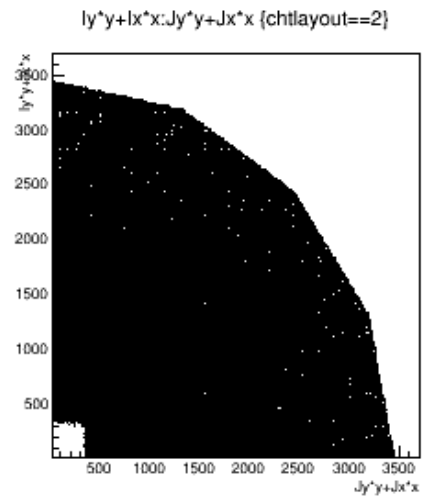
10.406 mm

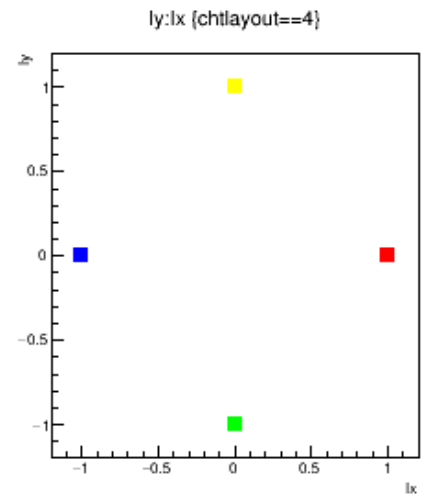
Hcal_Endcaps_SD_v01

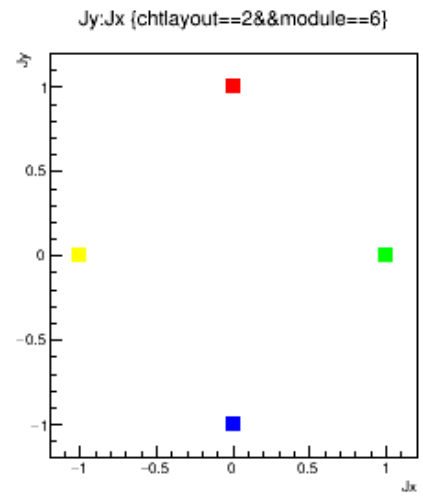








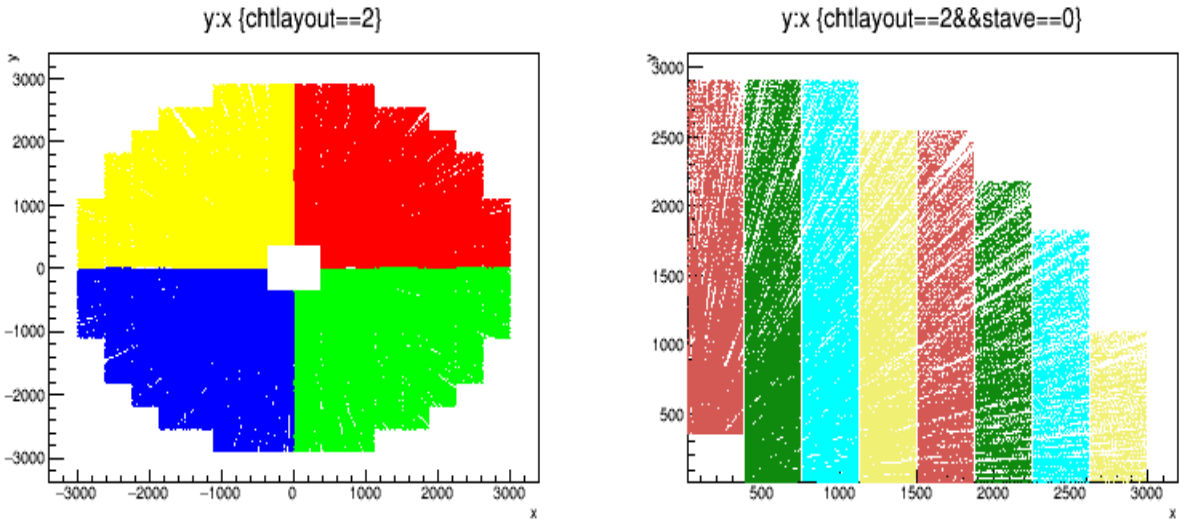




X,Y- resolutions:
pads directions

10.406 mm

ILD_l6_v02: Hcal_Endcaps_SD_v02



Analog of SHcalSC04 module with some differences

- 4 staves (instead of 2)
- 8 towers / stave (instead of 16)
- gaps between towers

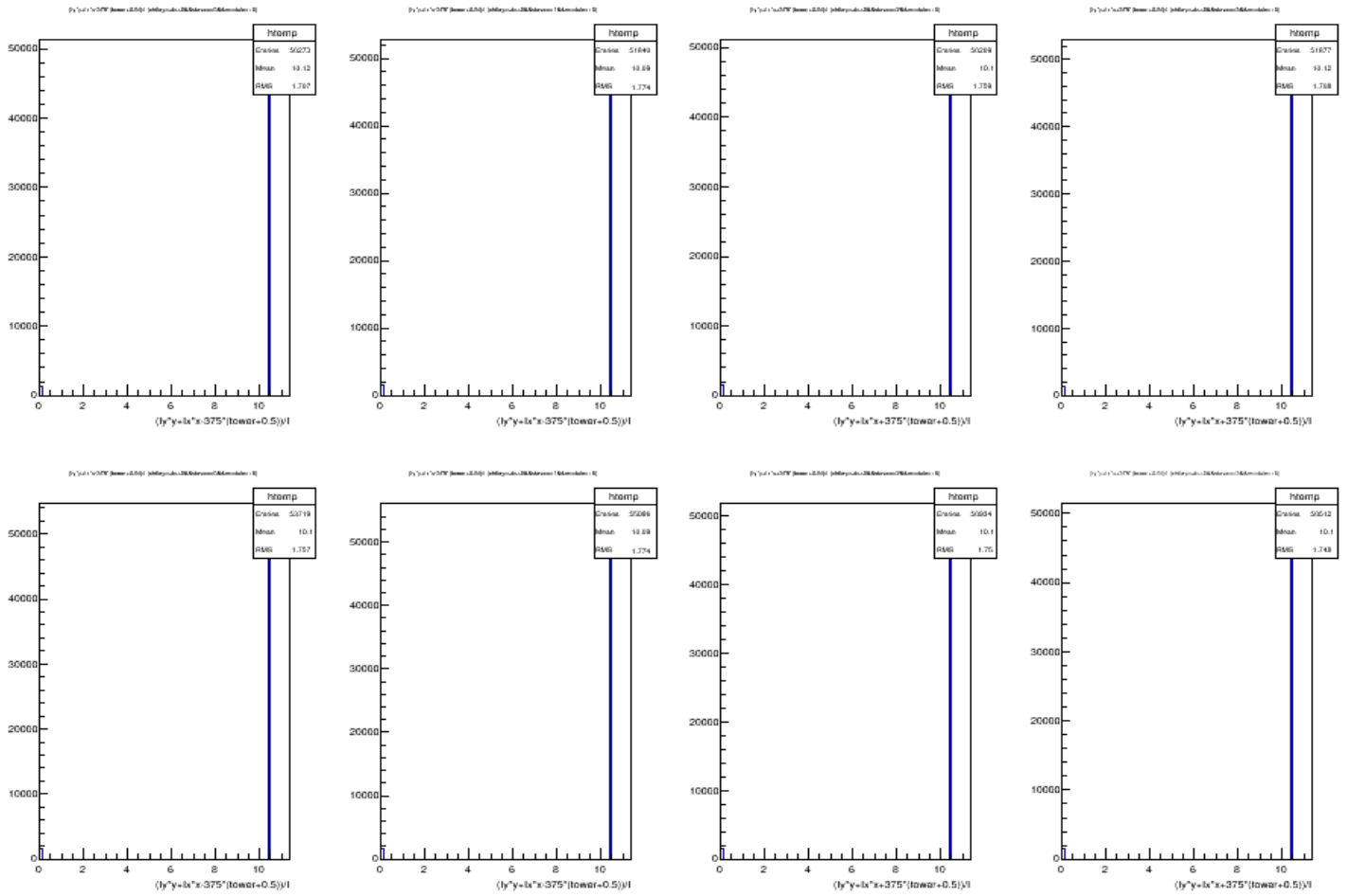
dimensions and positions hardwired in xml file

→ don't scale with envelope dimensions

…. modified SHcalSc04_Endcaps_sv01.xml – reduced size

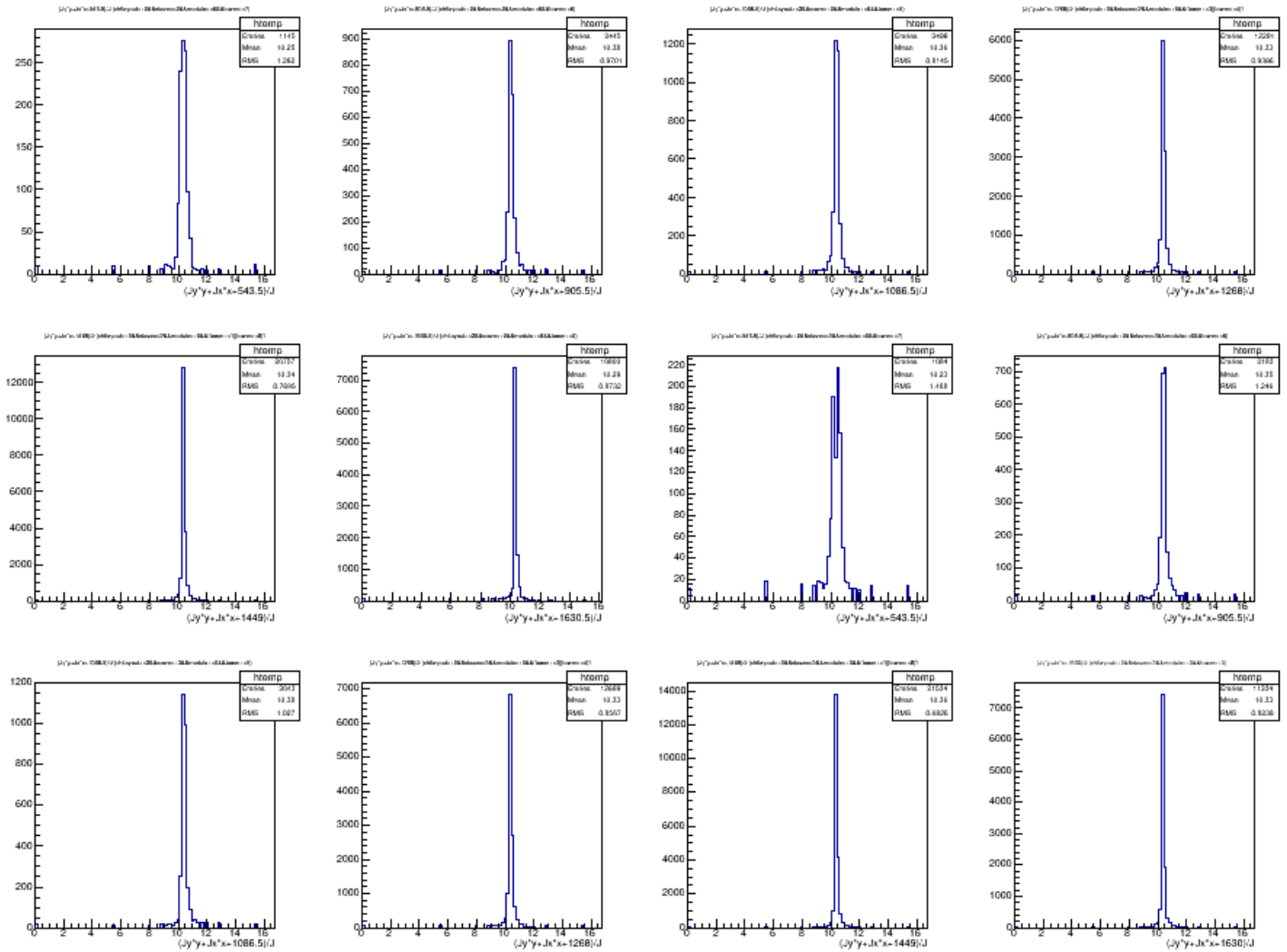
Hcal_Endcaps_SD_v02

X-resolutions



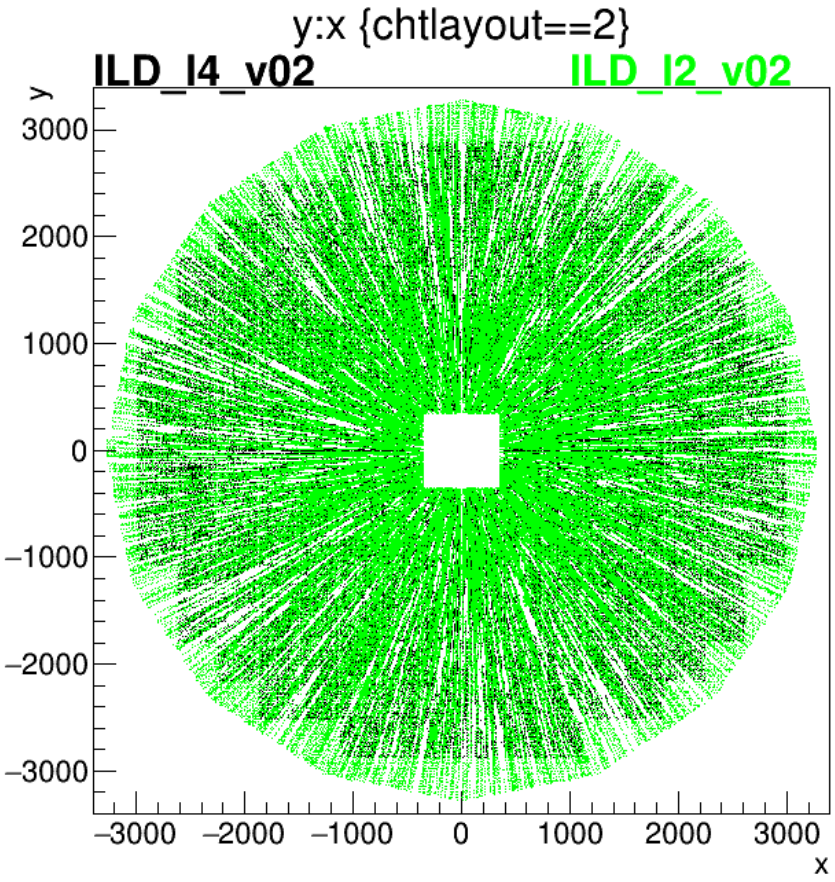
Hcal_Endcaps_SD_v02

Y-resolutions (per towers, modules)

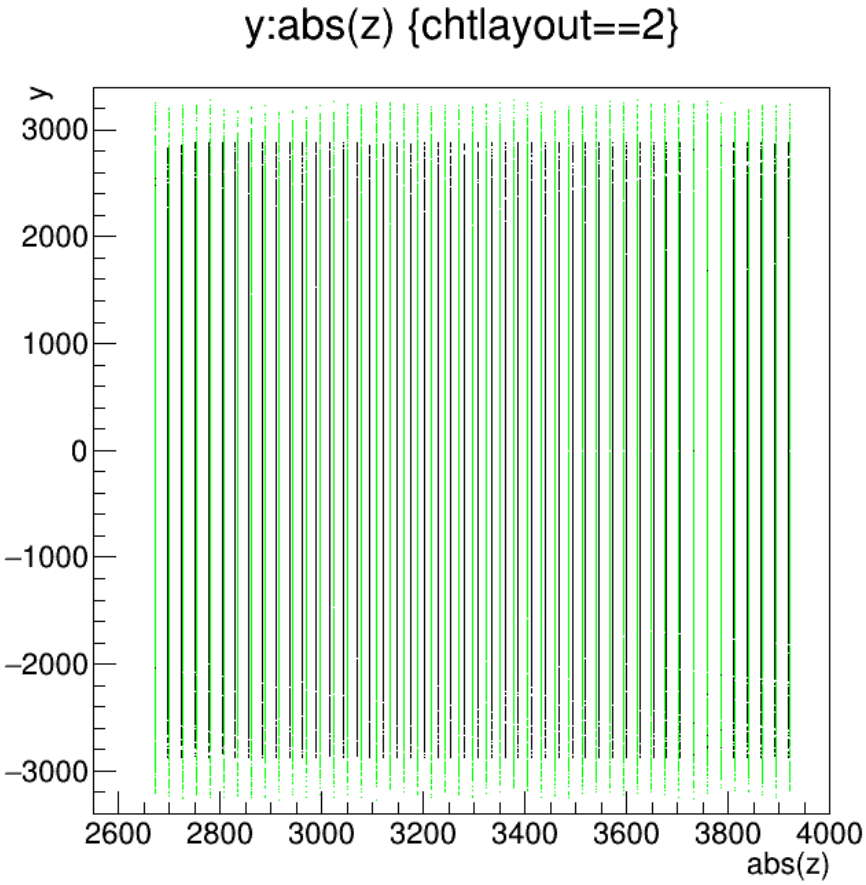


ILD_l4_v02 vs ILD_l2_v02

Endcaps Y:X

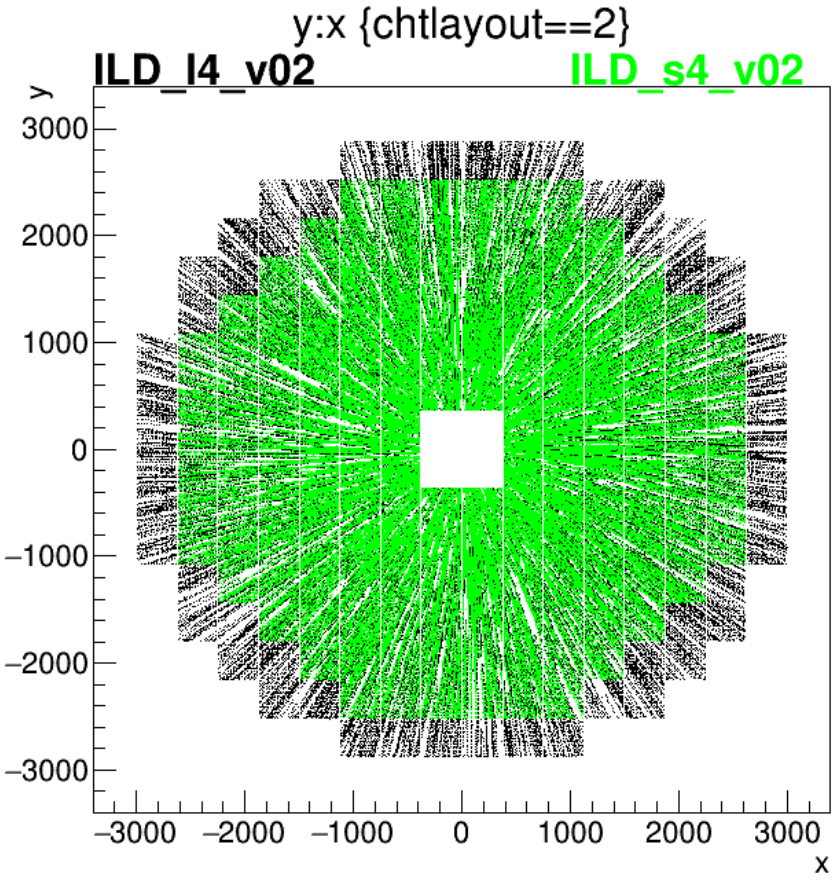


Y:Z

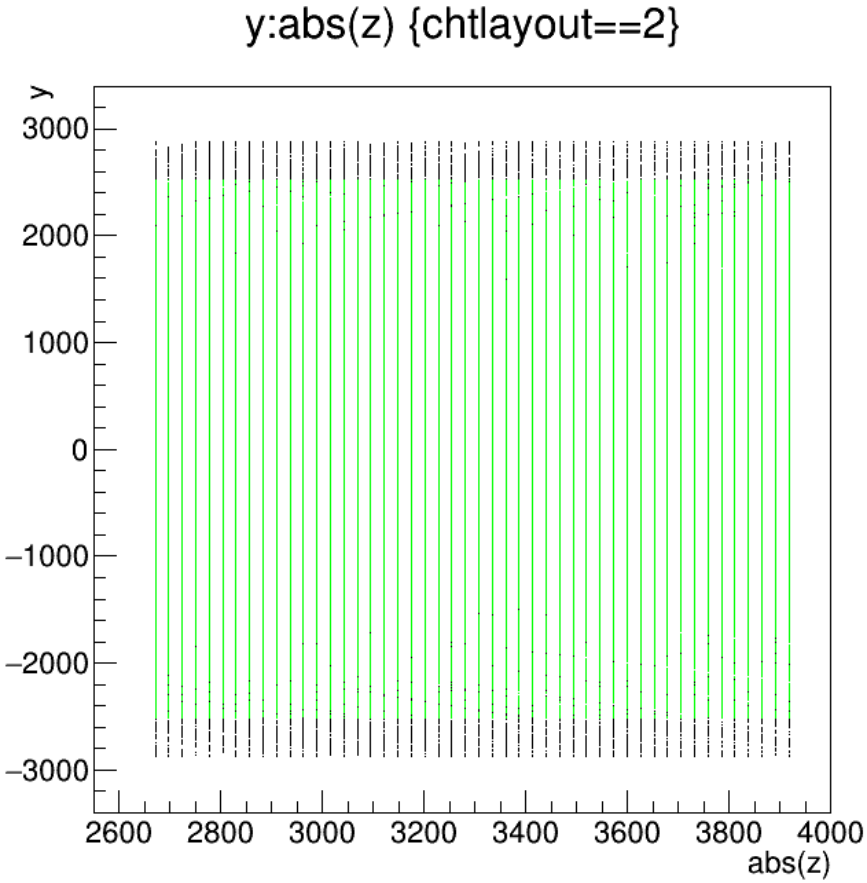


ILD_l4_v02 vs ILD_s4_v02

Endcaps Y:X

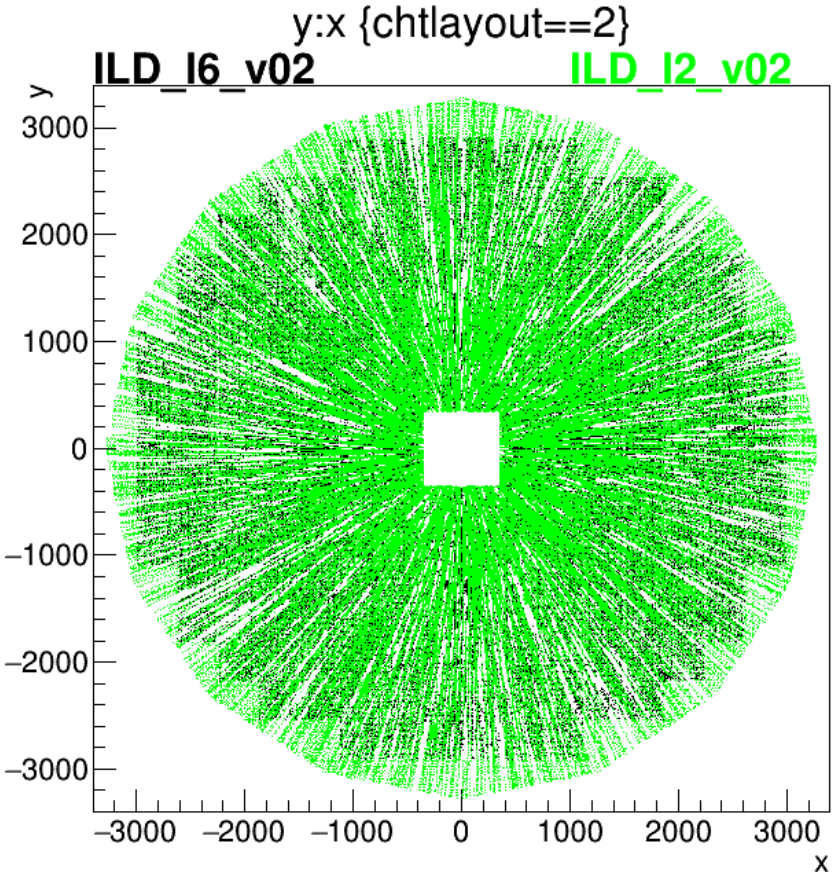


Y:Z

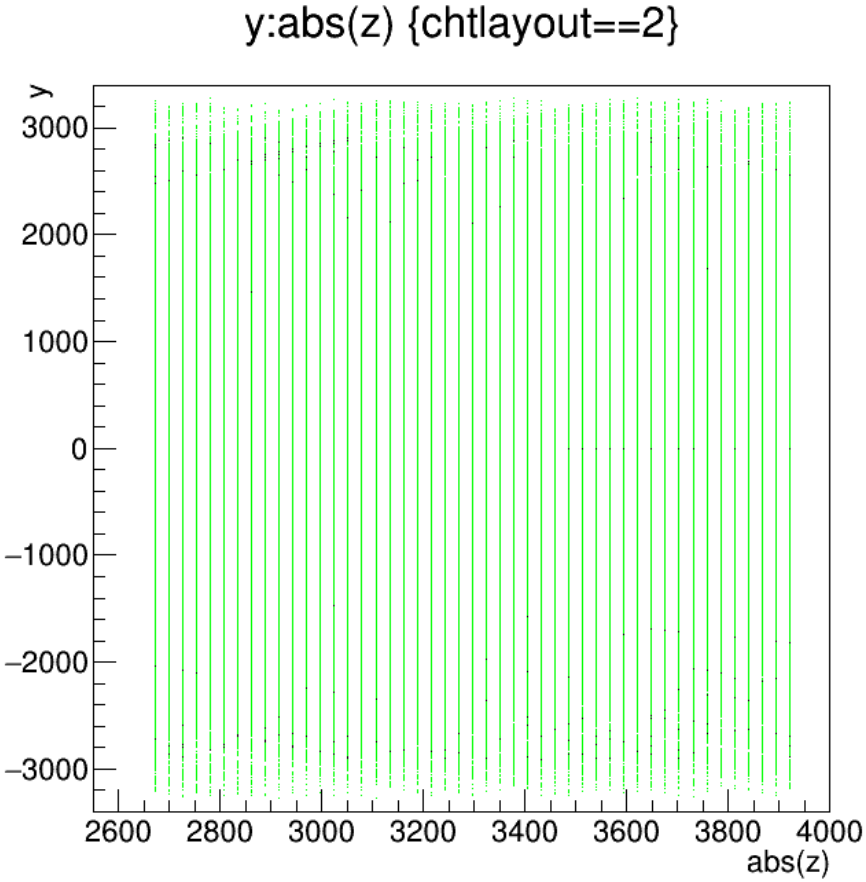


ILD_l6_v02 vs ILD_l2_v02

Endcaps Y:X

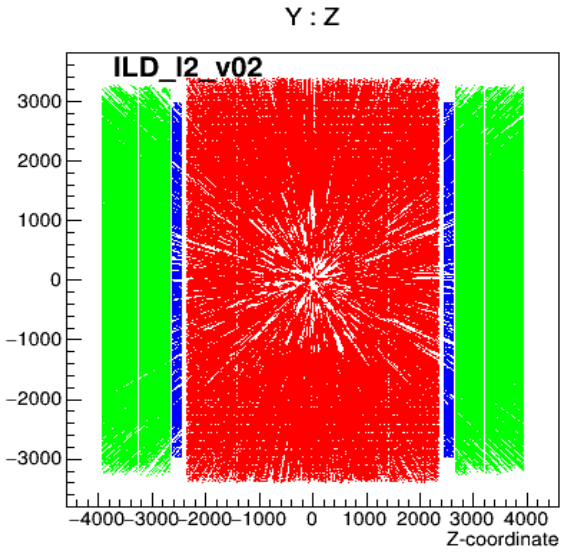


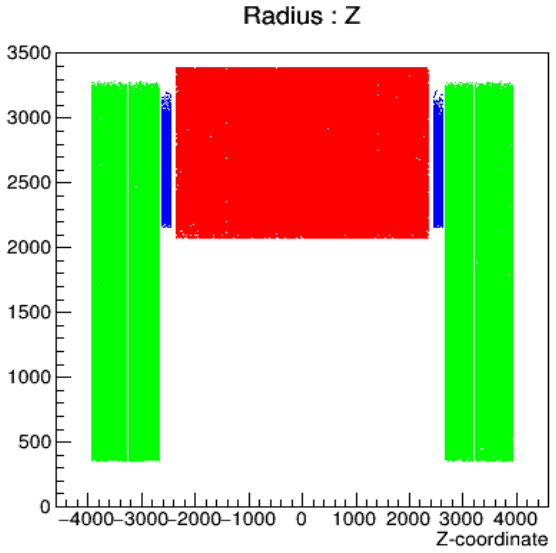
Y:Z



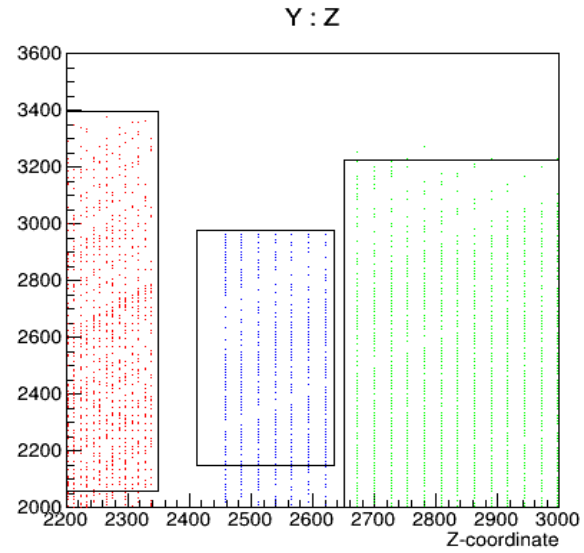
ILD_l2_v02

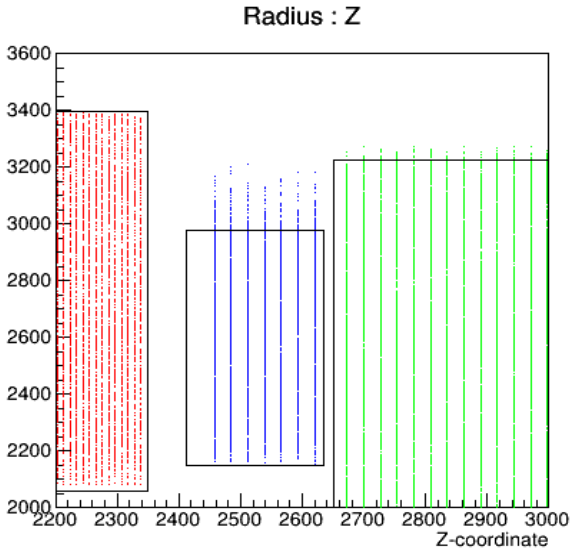
Y:Z





R:Z





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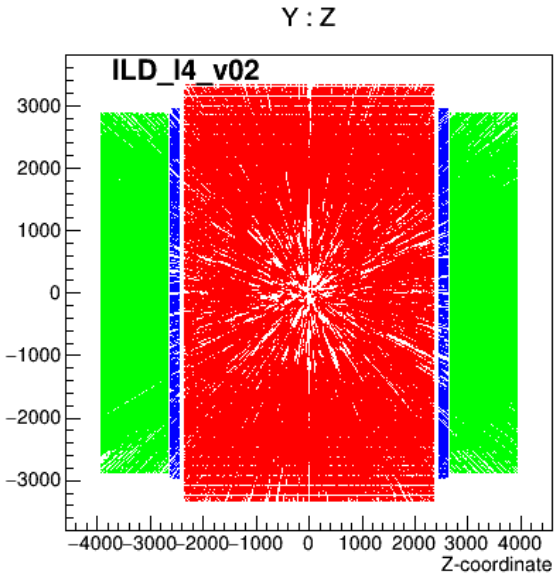
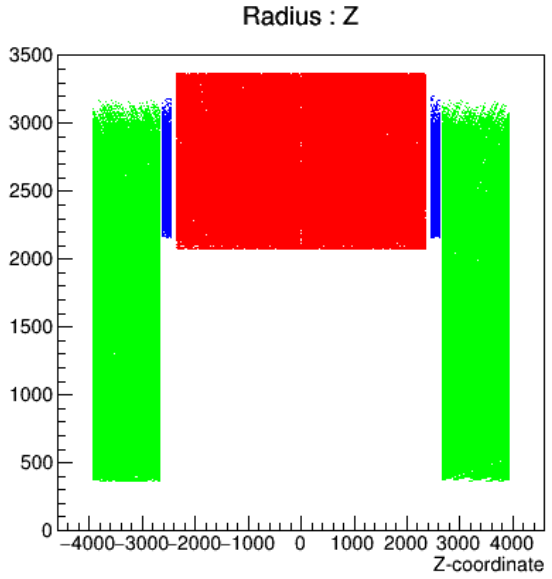
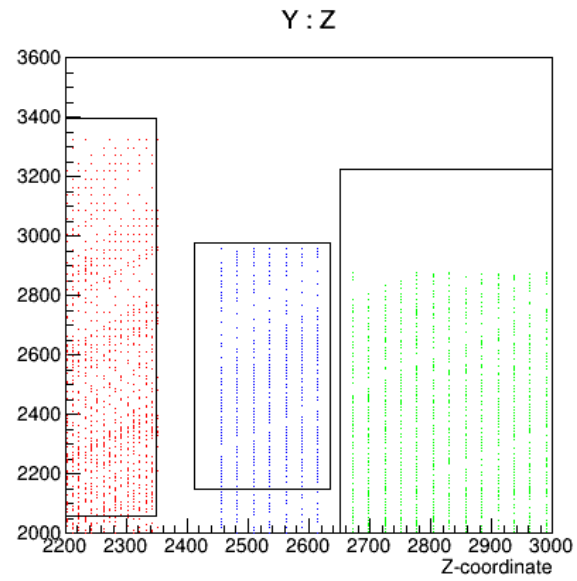
ILD_l4_v02

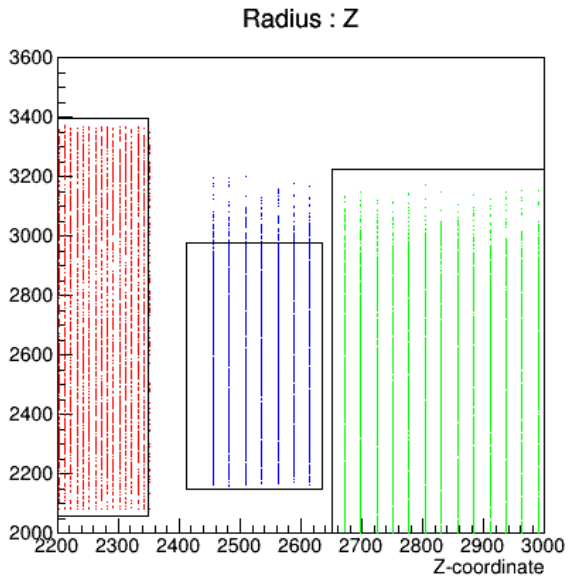
Y:Z





R:Z





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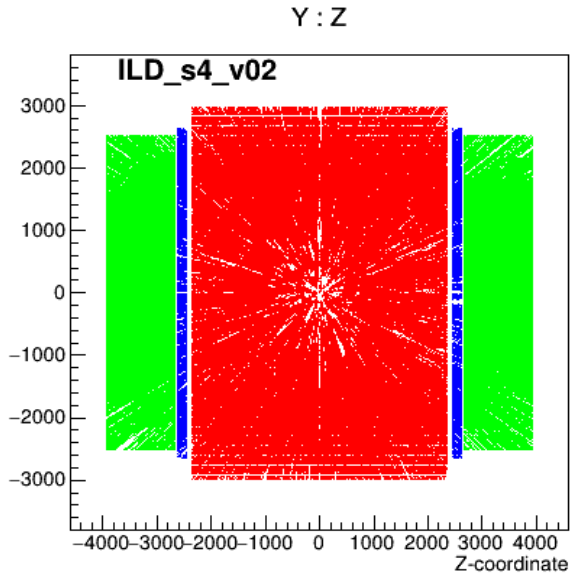
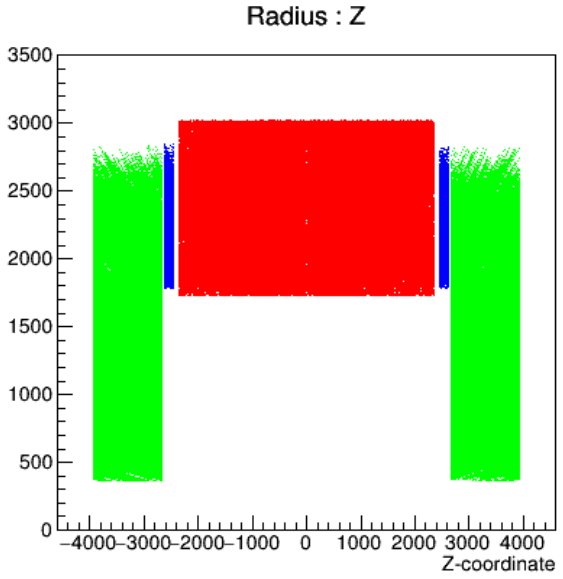
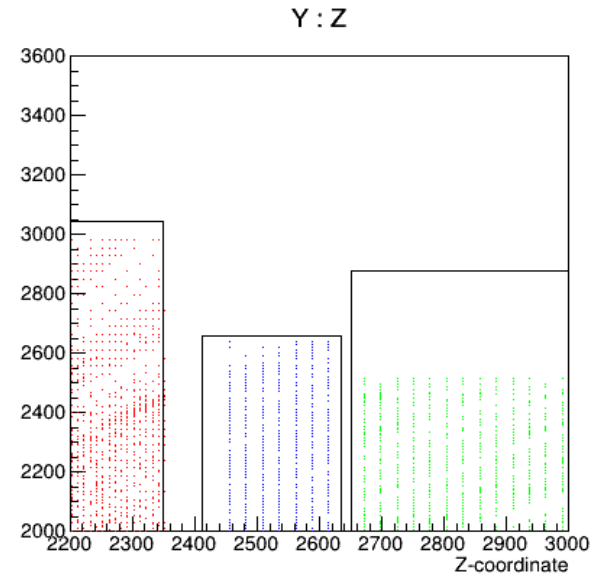
ILD_s4_v02

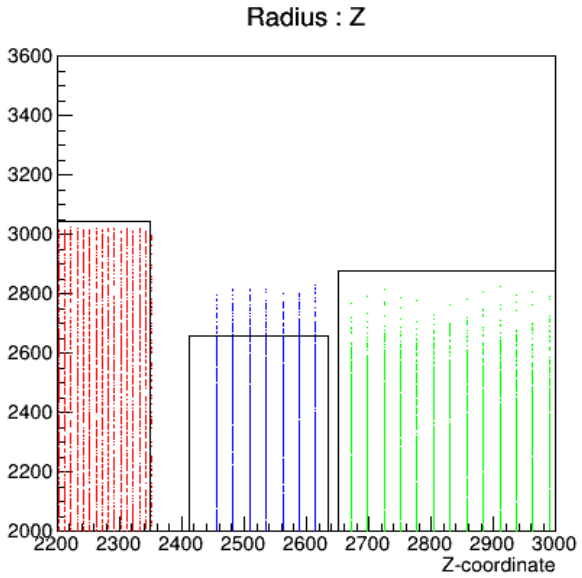
Y:Z





R:Z

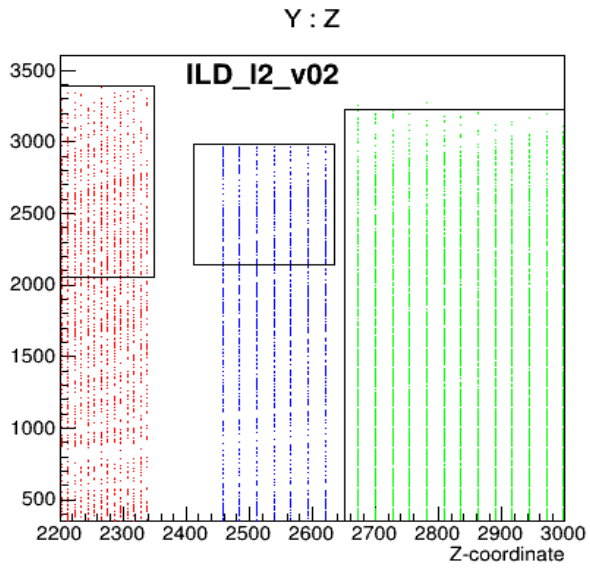


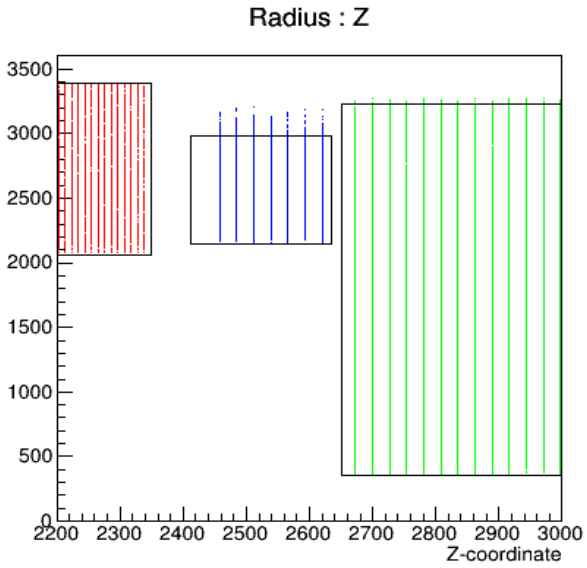


???

ILD_l2_v02 Endcaps,Ring

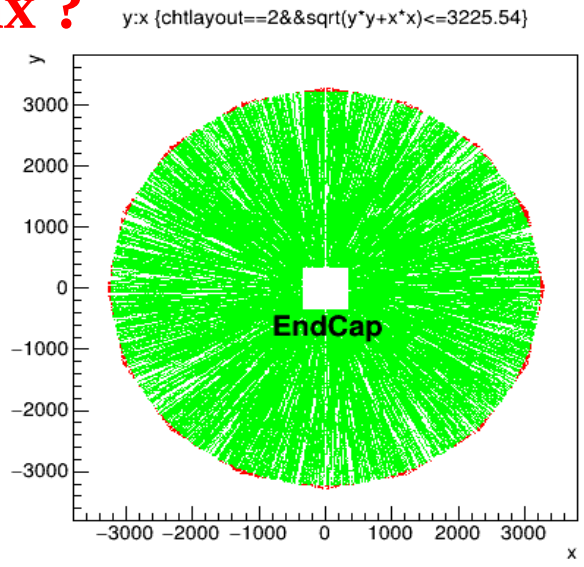
Y:Z

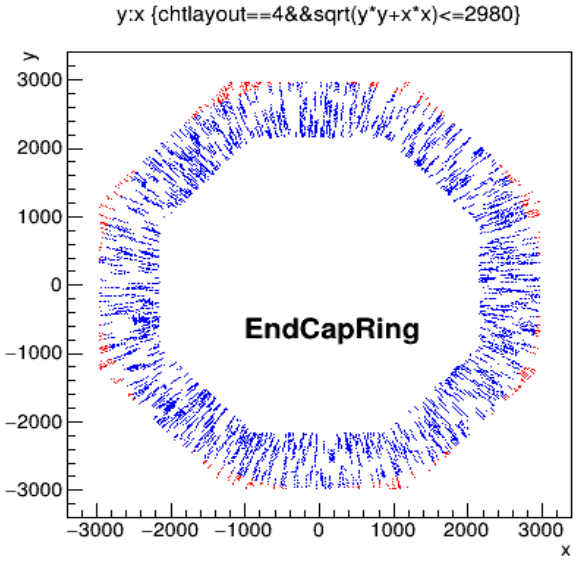




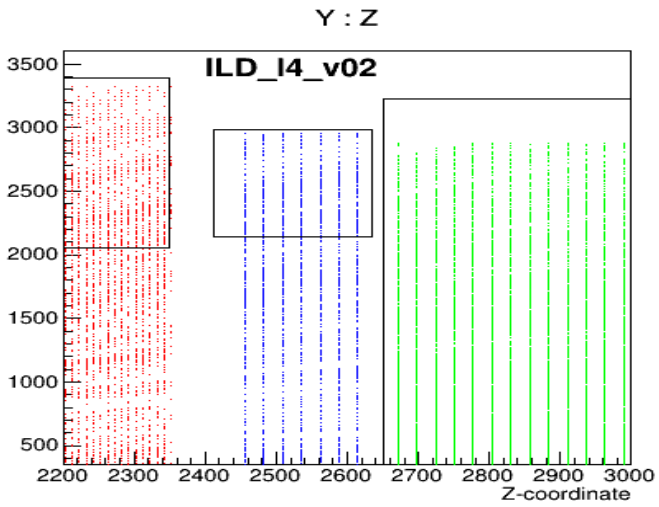
R:Z

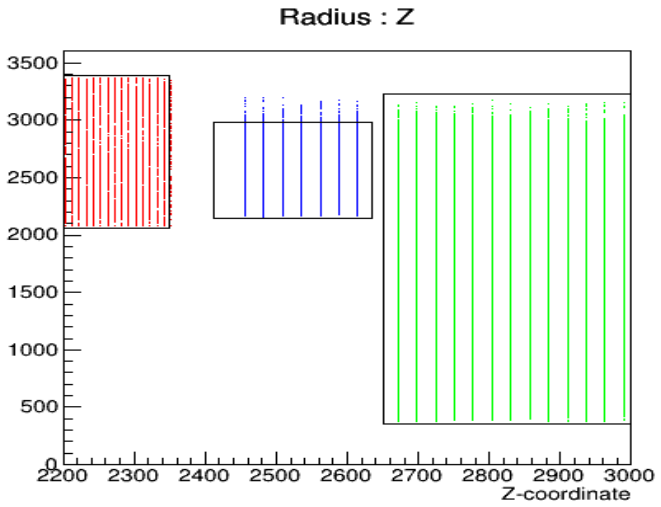
? R> R_max ?

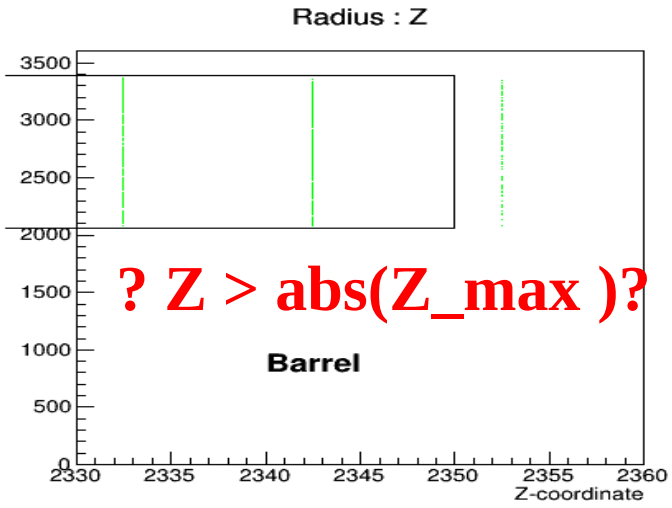


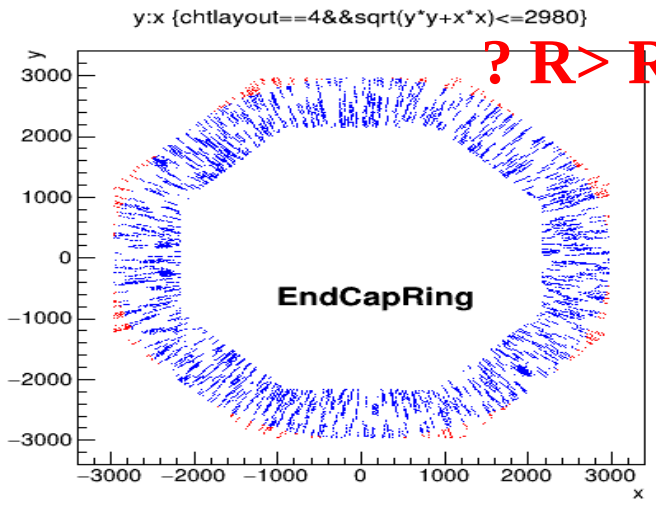


ILD_l4_v02 Barrel, Ring









Summary

✓ **SDHCAL models in lcgeo** (EndcapRing the same)

1. VIDEAU geometry **ILD_l2_v02, ILD_s2_v02**
2. TESLA geometry **ILD_l6_v02, ILD_s6_v02**

Corresponding to the engineering design:

- Hcal_Barrel_SD_v01
- detailed layer structure for all Hcal_SD subdetectors
  total layer thickness 27.125 mm
  #layers in Barrel,Endcap,Ring 48/48, 47/48, 7/7 resp.

Not fully corresponding to the engineering design:

- EndcapRing (outer symmetry 8→16)
- Endcaps

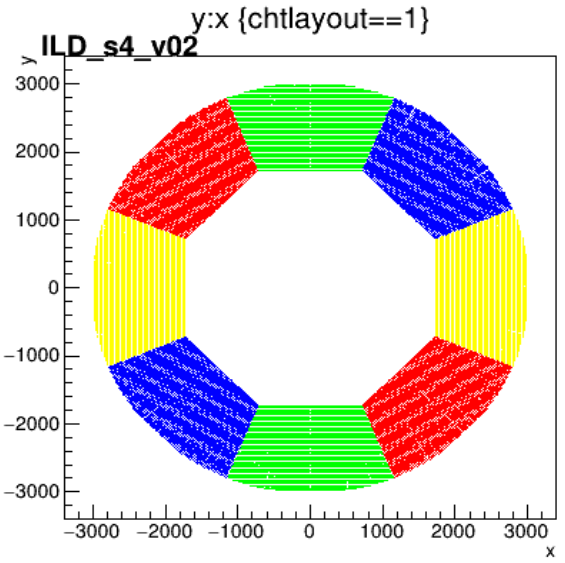
✓ **Tests/validation done with v01-19-05-pre04**

Issue ? - hits outside the max dimensions

- Backup slides

ILD_s4_v02

Y:X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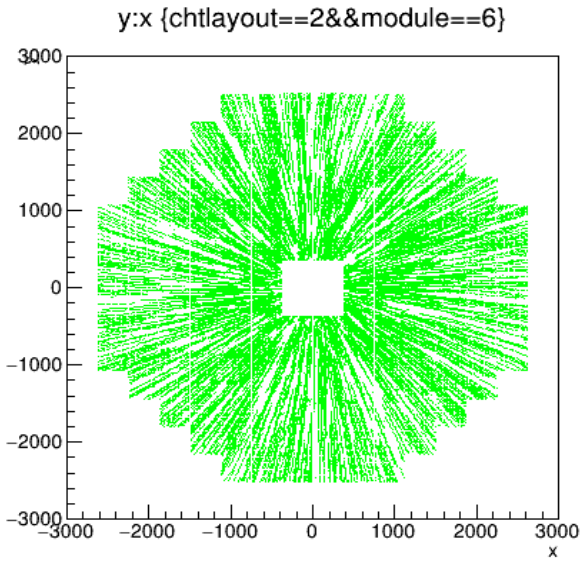
ILD_s4_v02
y
x
3000
2000
1000
0
−1000
−2000
−3000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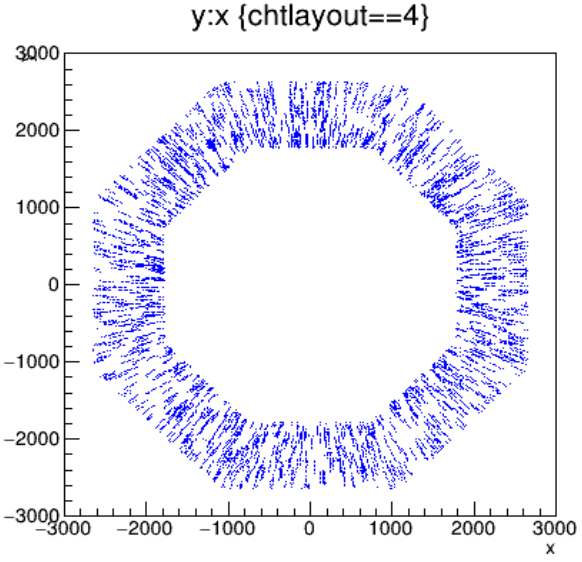
2000
1000
0
−1000
−2000
−3000
x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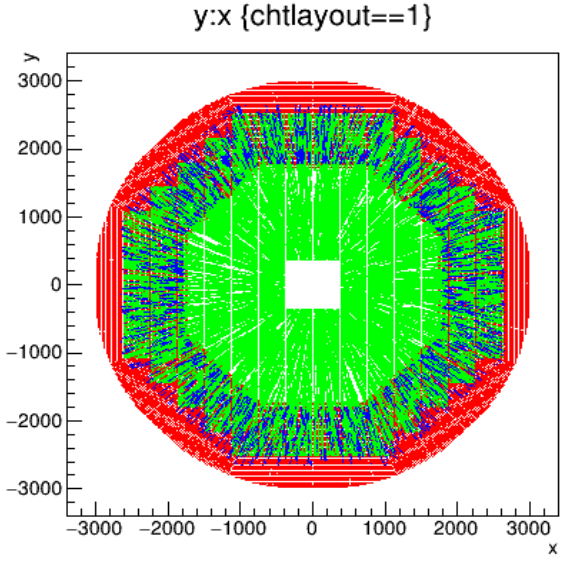
2000
1000
0
−1000
−2000
−3000
x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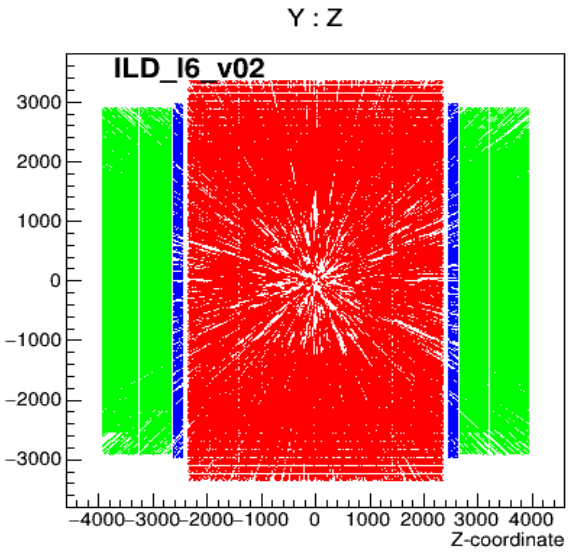
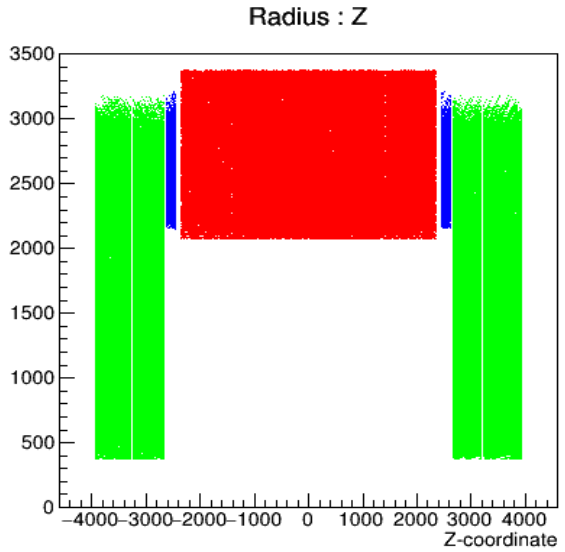
2000
1000
0
−1000
−2000
−3000
x

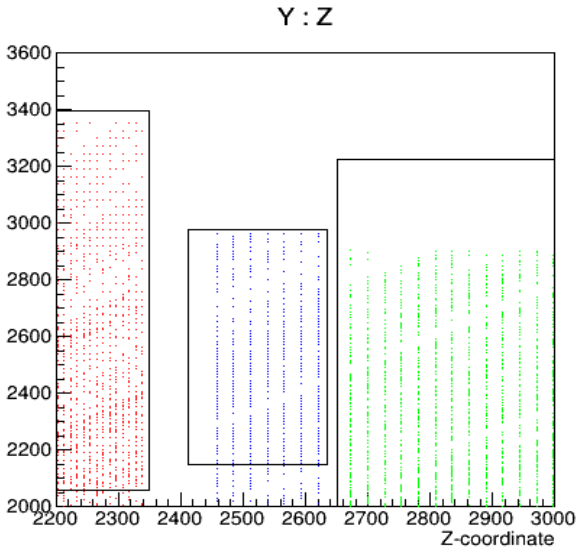
ILD_l6_v02

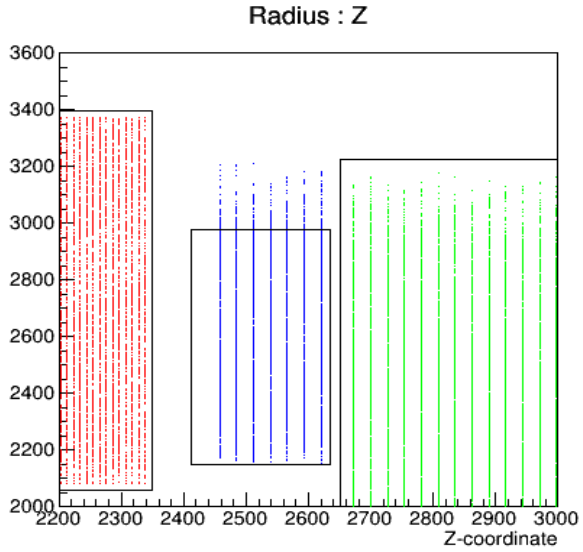
Y:Z





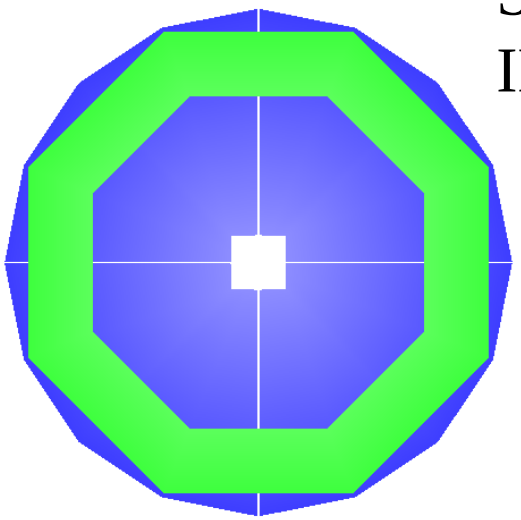
:Z

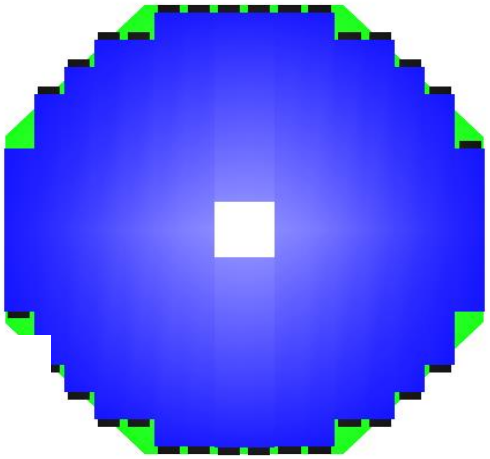


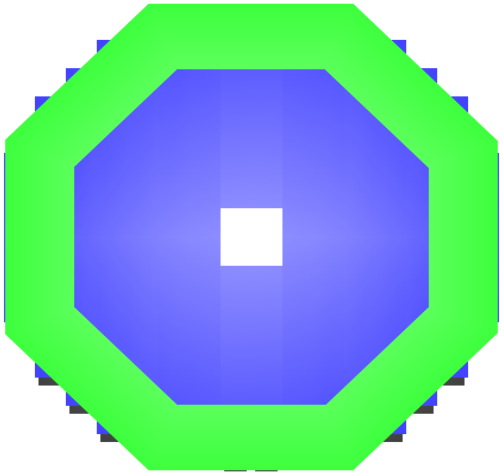


Hcal_Endcaps

SDHCAL
ILD_l2_v02





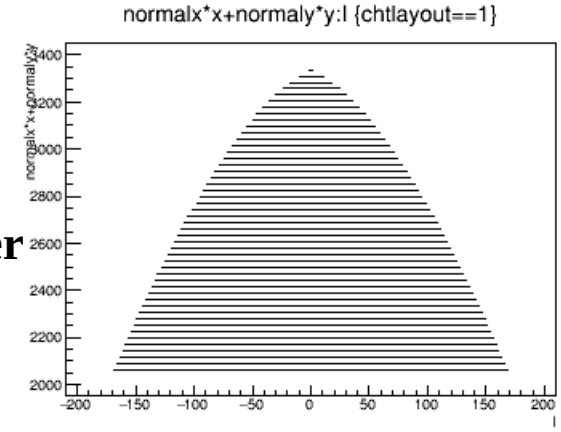


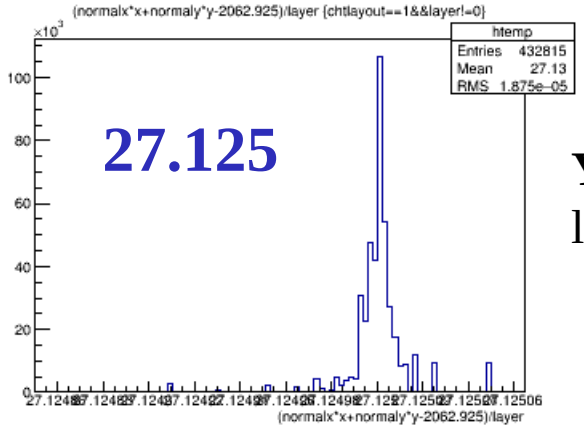
TESLA
ILD_l4_v02

Hcal_Barrel_SD_v01
y-, x- resolutions

Y: index I

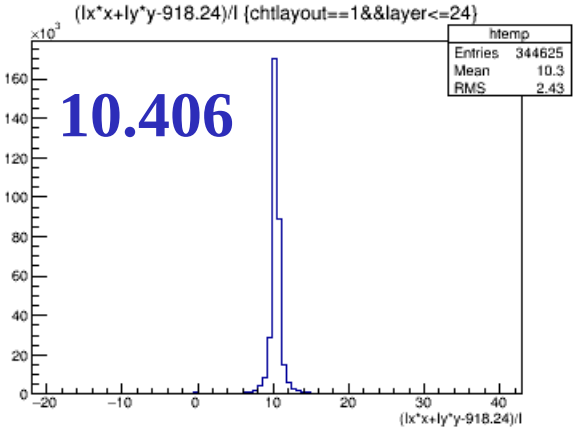
I= #pads/layer

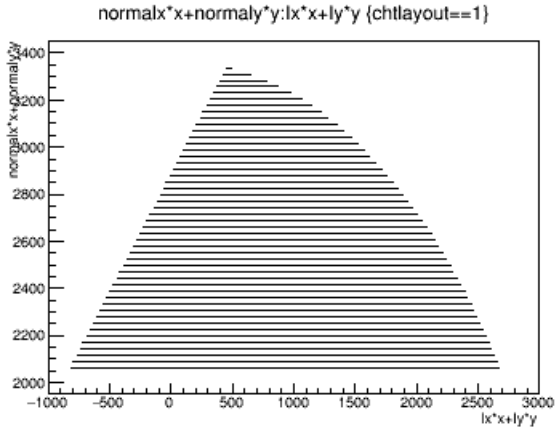




Y- 'resolution':
layers direction

X-'resolution':
pads direction
layer<24



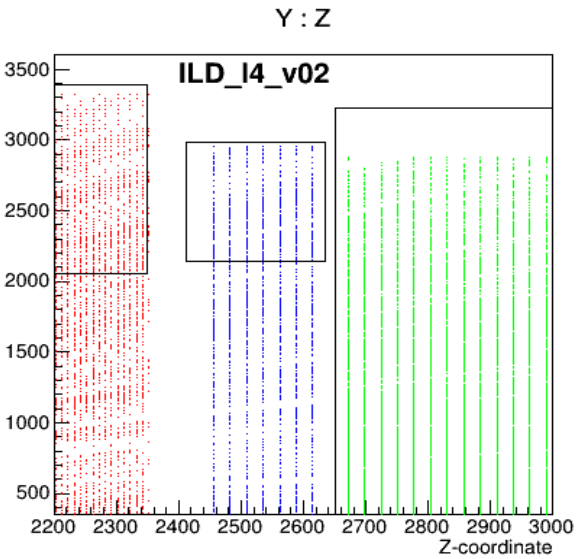


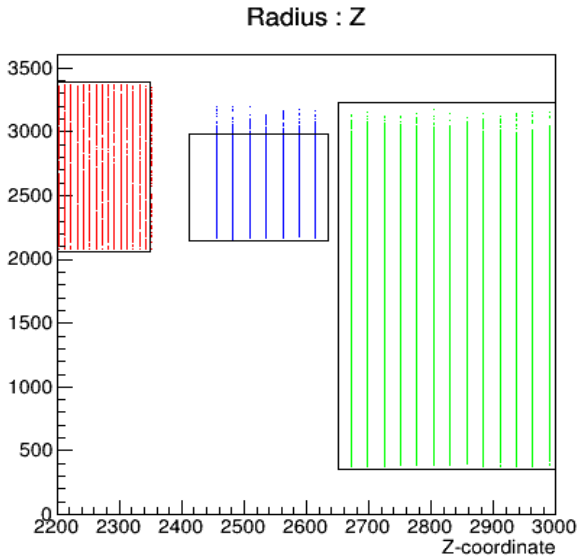
Y : X
staves projection

one has to know the exact x-shift of each layer
→ to get exactly the expected hit positions

ILD_l4_v02 Ring

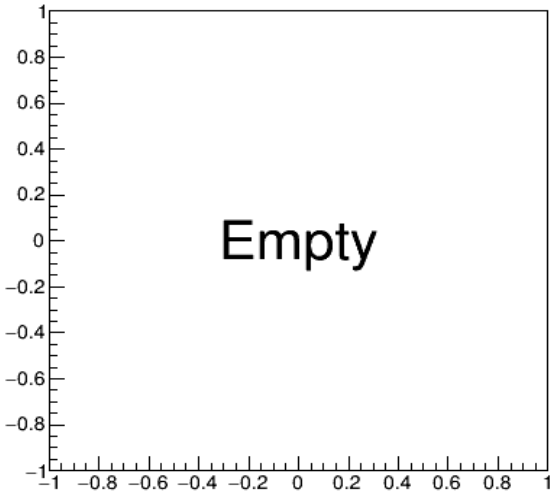
Y:Z

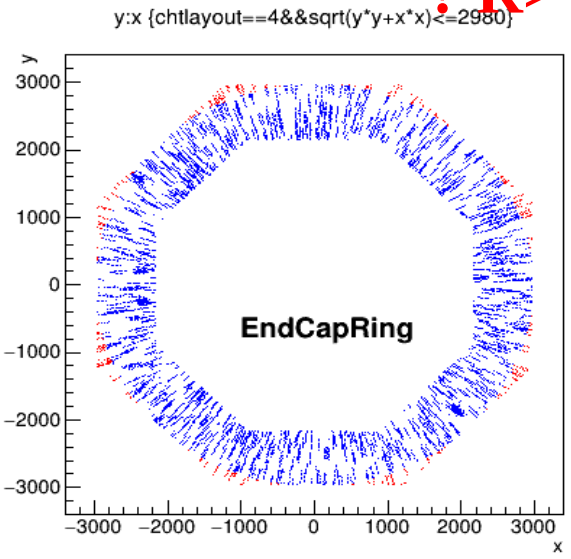




R:Z

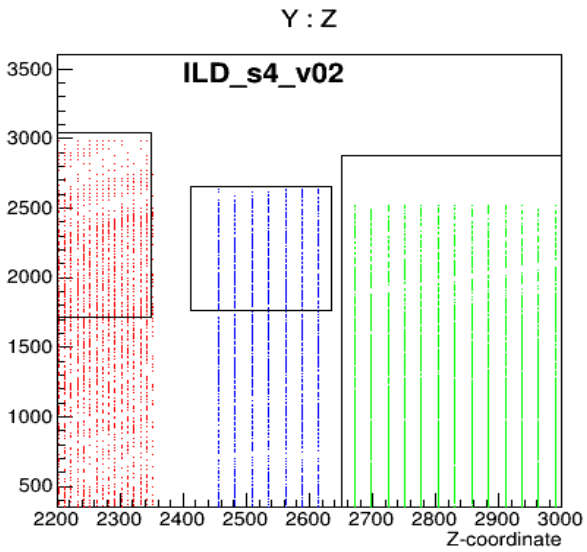
? R> R_max ?

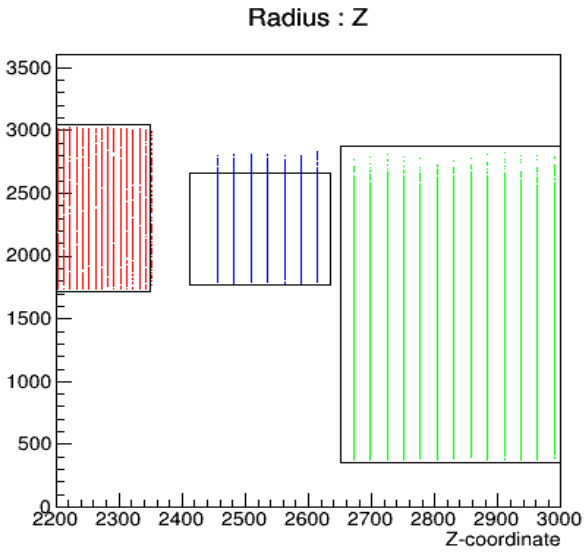




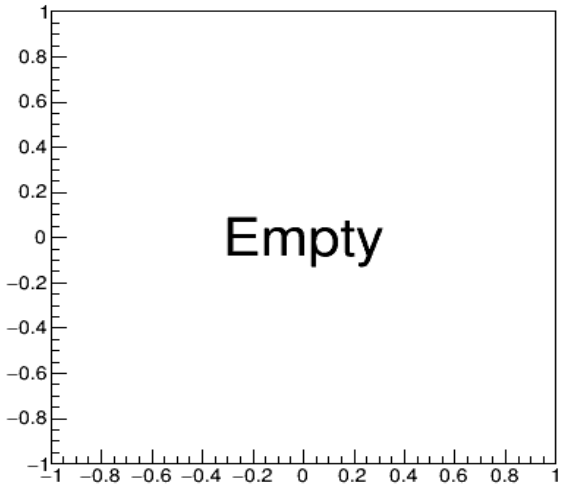
ILD_s4_v02 Ring

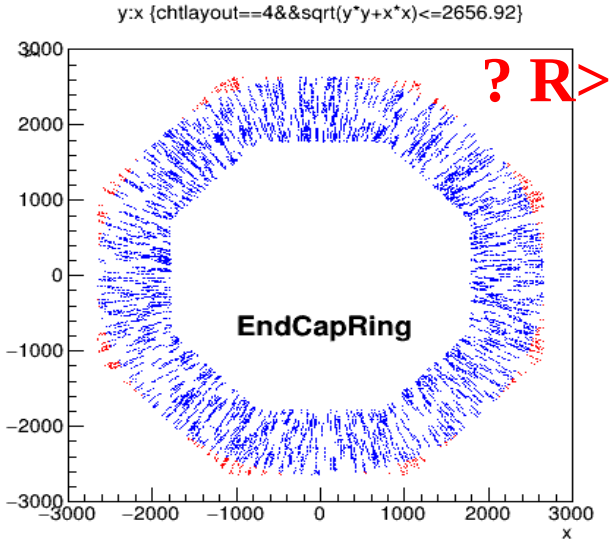
Y:Z





R:Z





? R> R_max ?