

1 TeV pair backgrounds with ILD_O1_v02

Preliminary study of pair background hits
with a new ILD detector model
Hits in VXD, TPC, FTD, BCAL

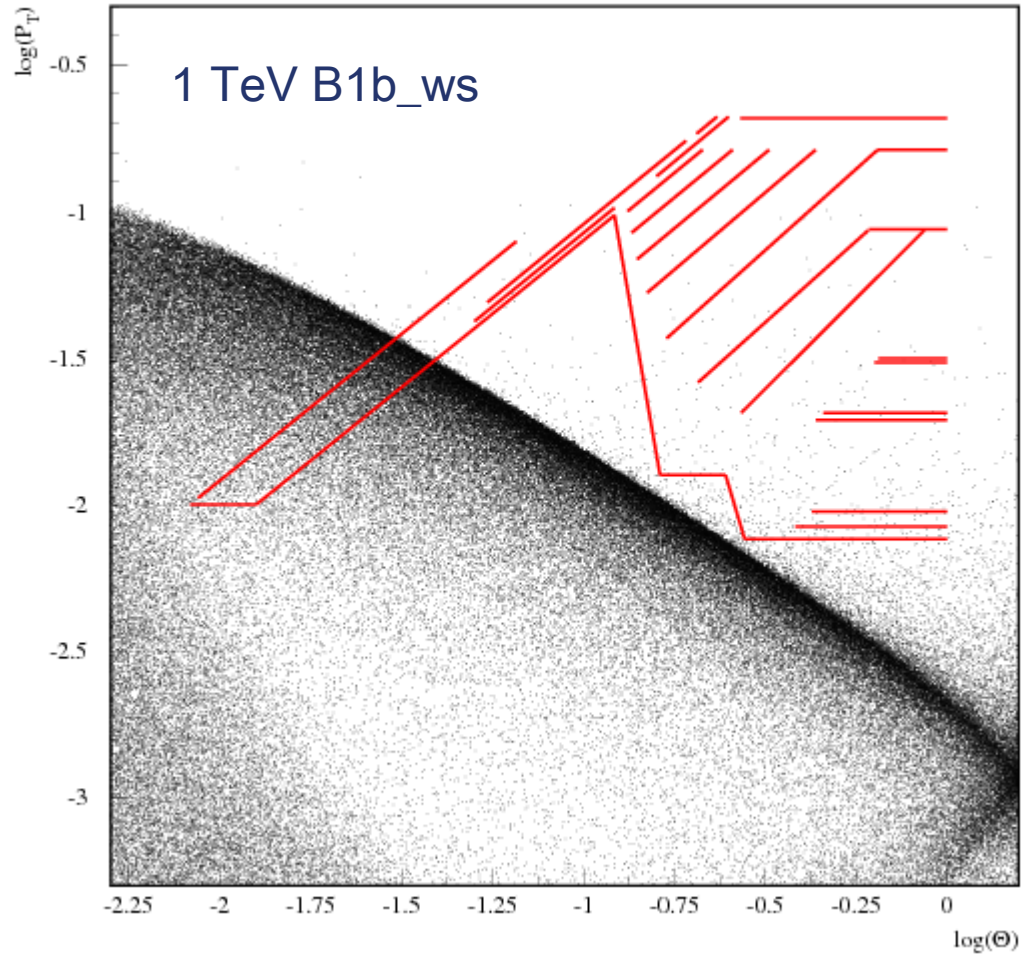
Akiya Miyamoto
KEK

25-April-2012
KILC12 Software Session

TDR beam parameter

<http://ilc-edmsdirect.desy.de/ilc-edmsdirect/item.jsp?edmsid=D00000000965015>

| | | | | | L upgrade | Ecm upgrade | |
|----------------------------------|---|-------|-------|-------|-----------|-------------|-------------|
| Center of mass energy | GeV | 250 | 350 | 500 | 500 | A1 | B1b |
| Collision rate | Hz | 5 | 5 | 5 | 5 | 4 | 4 |
| Number of bunches | | 1312 | 1312 | 1312 | 1312 | 2450 | 2450 |
| e-(e+) bunch poplation | $\times 10_{10}$ | 2 | 2 | 2 | 2 | 1.74 | 1.74 |
| Bunch separation | ns | 554 | 554 | 554 | 366 | 366 | 366 |
| RMS bunch length | mm | 0.3 | 0.3 | 0.3 | 0.3 | 0.25 | 0.225 |
| Electron RMS energy spread | % | 0.190 | 0.158 | 0.125 | 0.125 | 0.083 | 0.085 |
| Positron RMS energy spread | % | 0.150 | 0.100 | 0.070 | 0.070 | 0.043 | 0.047 |
| Electron polarization | % | 80 | 80 | 80 | 80 | 80 | 80 |
| Positron polarization | % | 30 | 30 | 30 | 30 | 20 | 20 |
| Horizontal emittance | m | 10 | 10 | 10 | 10 | 10 | 10 |
| Vertical emittance | nm | 35 | 35 | 35 | 35 | 30 | 30 |
| IP horizontal beta function | mm | 12 | 15 | 11 | 11 | 22.6 | 11 |
| IP vertical beta function(no TF) | mm | 0.48 | 0.48 | 0.48 | 0.48 | 0.25 | 0.23 |
| IP RMS horizontal beam size | nm | 700 | 662 | 474 | 474 | 481 | 335 |
| IP RMS vertical beam size(no TF) | mm | 8.3 | 7 | 5.9 | 5.9 | 2.8 | 2.7 |
| Coherent waist shift | m | 250 | 250 | 250 | 250 | 190 | 190 |
| Luminosity incl. waist shift | $\times 10^{34} \text{cm}^{-2} \text{s}^{-1}$ | 0.8 | 0.9 | 1.8 | 3.6 | 3.6 | 4.9 |
| Fraction of lum. in top 1% | % | 84.1 | 79.3 | 62.5 | 62.3 | 60.2 | 45.5 |
| Average energy loss | % | 1.23 | 1.75 | 4.3 | 4.3 | 5.3 | 9.9 |
| Number of pairs per BX | $\times 10^3$ | 70.5 | 89.1 | 139 | 139 | 200.5 | 382.6 >1MeV |



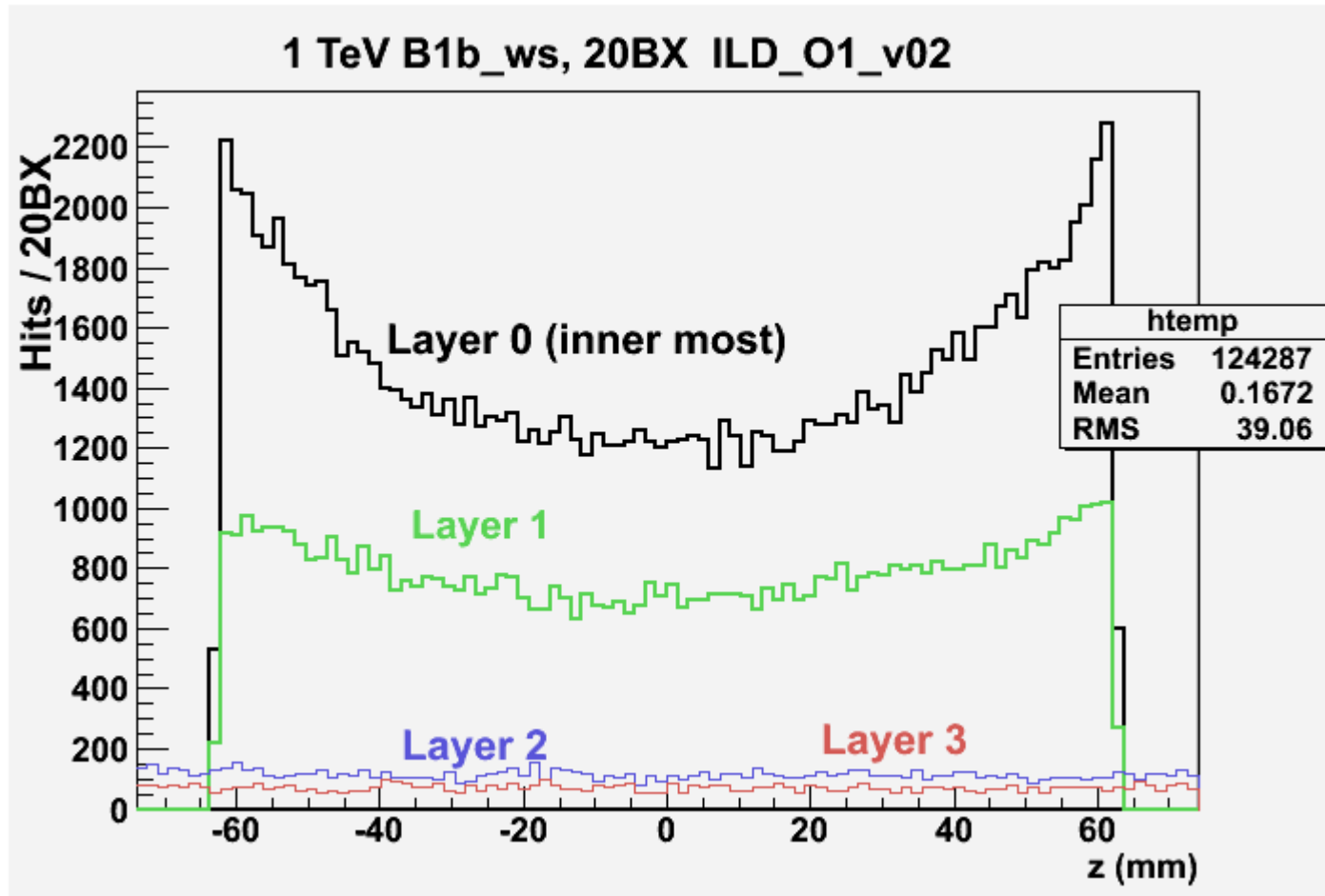
By Mikael Berggren

Simulation conditions

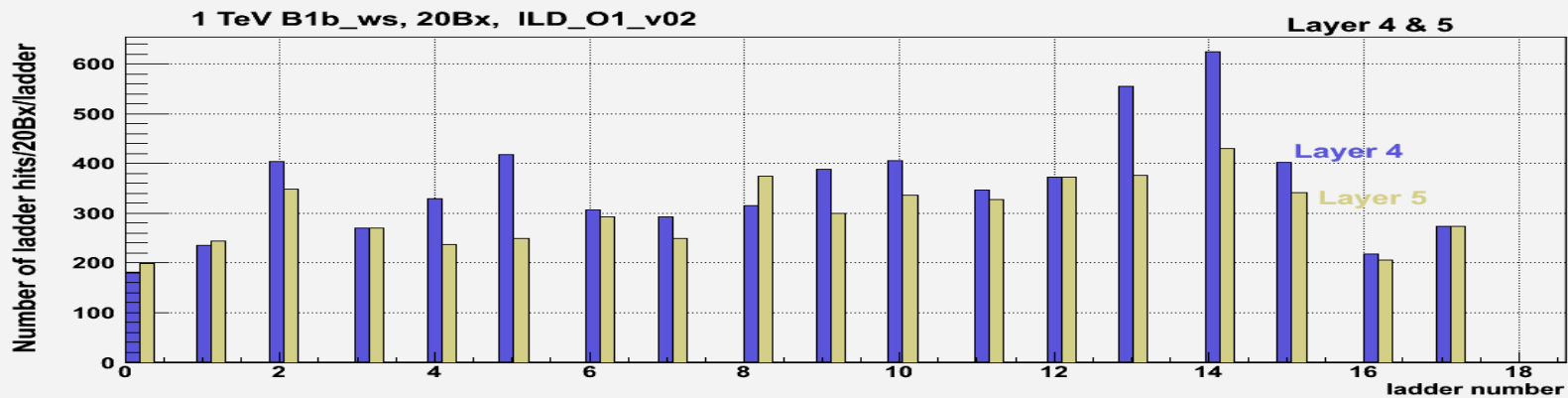
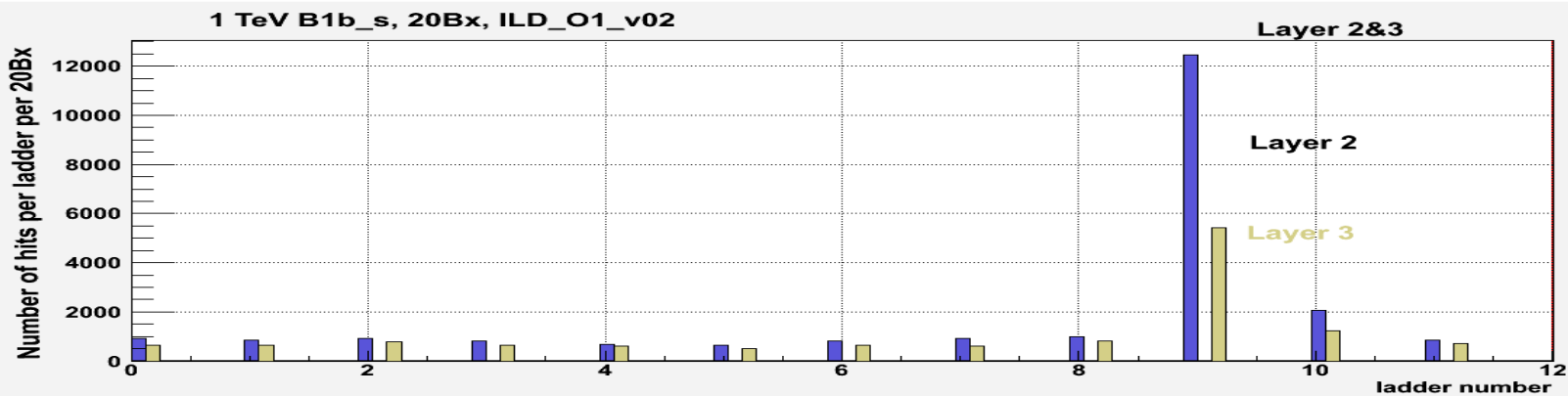
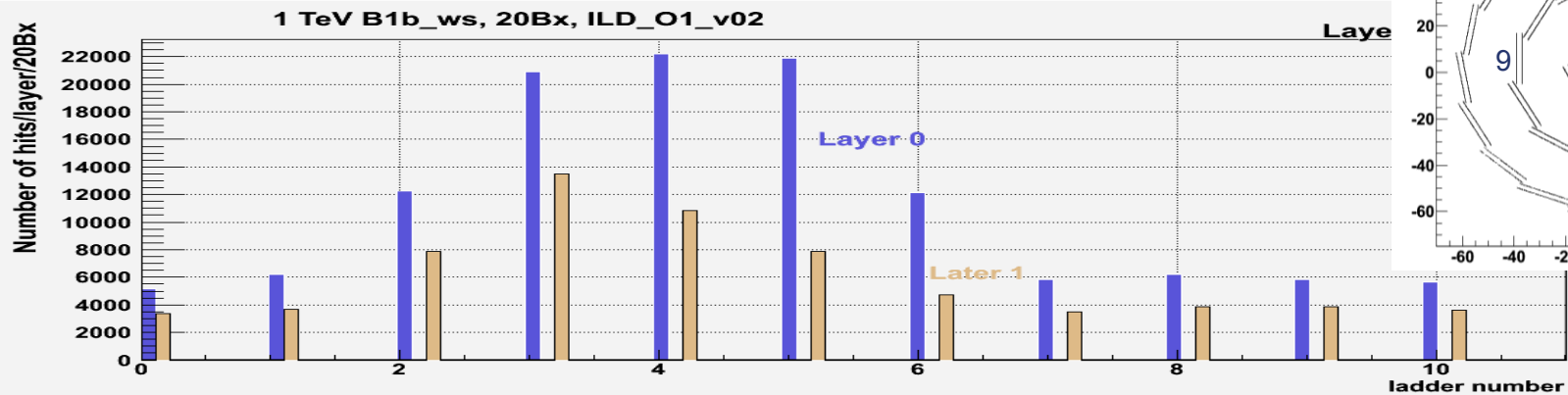
- GuineaPig files : produced by Hartin. Taken from
`/afs/desy.de/group/flc/pool/analysis/public/pairs/hartin/[1000,500]GeV`
 - `Waisty_opt_Jan2012_1000GeV_B1b_runX_waisty_190 20BX`
 - `Waisty_opt_Jan2012_500GeV_run9_waisty_250 7BX`
- Mokka: `ilcsoft-v01-13-04`, `Mokka-07-07`
 - `ILD_O1_v02` (exist overlap geometry in beam pipe, ... not perfect yet.)
 - `ILD_00fwp01` (500GeV) for comparison with LOI
- Setting for Anti-DID and pair simulation in `mokka.steer`
 - `/Mokka/init/EditGeometry/rmSubDetector SField01`
 - `/Mokka/init/EditGeometry/addSubDetector fieldX03 1000`
 - `/Mokka/init/lcioDetailedTRKHitMode SITCollection`
 - `/Mokka/init/lcioDetailedTRKHitMode VXDCollection`
 - `/Mokka/init/lcioDetailedTRKHitMode FTDCollection`
 - `/Mokka/init/lcioDetailedTRKHitMode TPCCollection`
 - `/Mokka/init/lcioDetailedTRKHitMode TPCSpacePointCollection`
 - `/Mokka/init/TPCLowPtStepLimit true`
 - `/Mokka/init/pairParticlesPerEvent 100`
 - `/Mokka/init/TPCCut 0 keV`
 - `/Mokka/init/RangeCut 0.1mm`



Z distribution



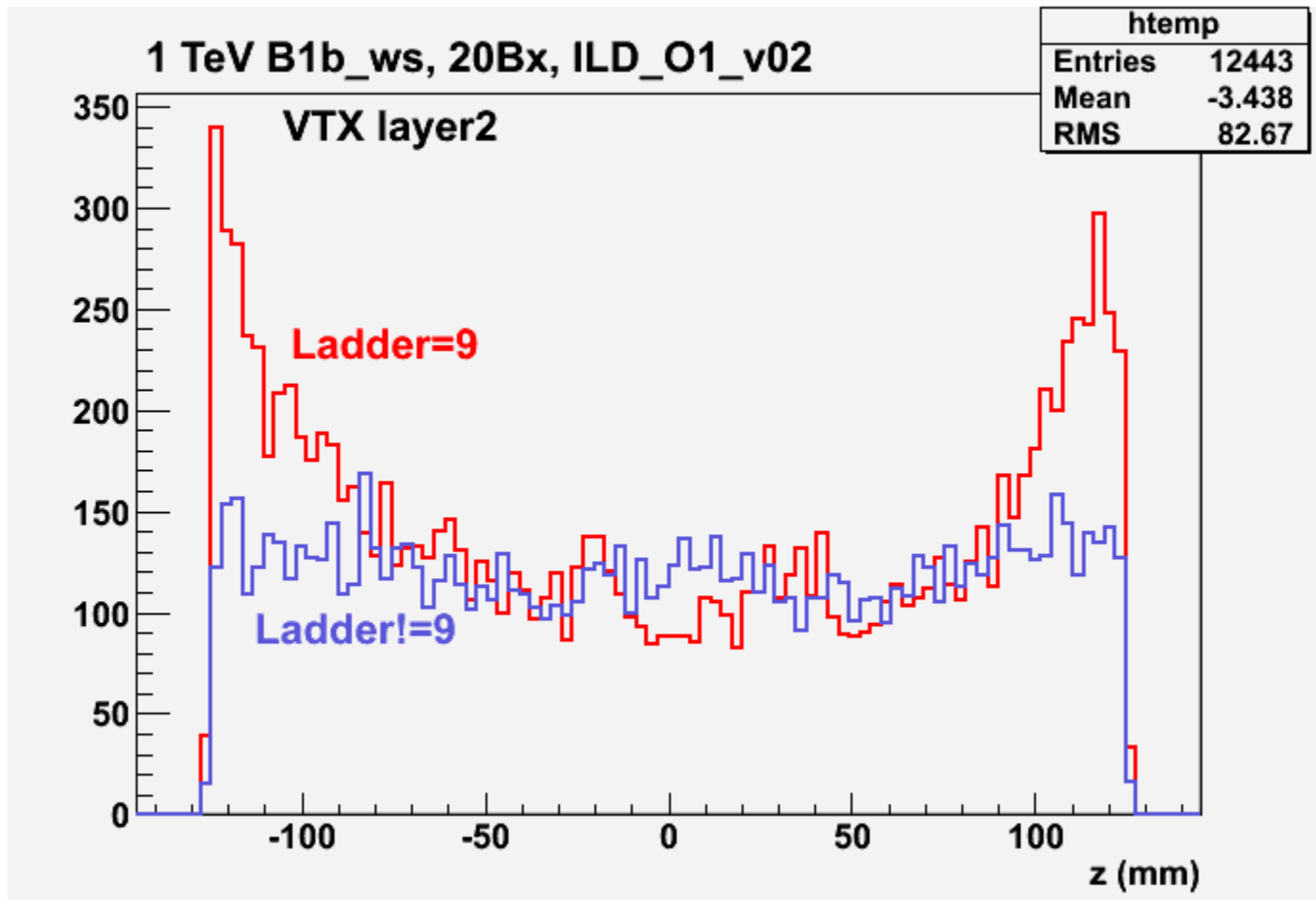
Phi dependence of VTX hits



Layer 2 ladder 9:

Z distribution of ladder 9 is similar to layer0 ladders.

Many hits due to back scattering ?



VTX geometry to calculate hit occupancy

- Hit occupancy is calculated assuming 1 SimTrackerHit create 4 pixel hits

$$\text{Occupancy} = \frac{4 * (\# \text{ of simtracker hits /BX}) * (\# \text{ of BXs/Read out})}{\text{total number of pixels}}$$

Ladder width 11 mm
 Half length
 Layer 0&1 62.5 mm

Readout time
 CMOS layer0&1 46 usec
 layer2,3,4,5 184 usec

1 TeV
 FPCCD inter-pulse
 Number of bunches 2450
 bunch separation 366 nsec

| Layer | Width (mm) | HalfL (mm) | #Ladder | CMOS like | | | FPCCD like | | | FPCCD/CMOS |
|-------|------------|------------|---------|-----------|-------------------------------|-------------|------------|-------------------------------|-------------|------------------|
| | | | | #BX/RO | Pixel size (um ²) | #Pixels (M) | #BX/RO | Pixel size (um ²) | #Pixels (M) | #RO/#Pixel ratio |
| 0&1 | 11 | 62.5 | 11 | 125 | 25 ² | 24.2 | 2450 | 5 ² | 605 | 0.784 |
| 2&3 | 22 | 125 | 12 | 504 | 25 ² | 105.6 | 2450 | 5 ² | 2640 | 0.194 |
| 4&5 | 22 | 125 | 18 | 504 | 25 ² | 158.4 | 2450 | 5 ² | 3960 | 0.194 |

500 GeV number of bunches 1312
 bunch separation 554 nsec

| Layer | Width (mm) | HalfL (mm) | #Ladder | CMOS like | | | FPCCD like | | | FPCCD/CMOS |
|-------|------------|------------|---------|-----------|-------------------------------|-------------|------------|-------------------------------|-------------|------------------|
| | | | | #BX/RO | Pixel size (um ²) | #Pixels (M) | #BX/RO | Pixel size (um ²) | #Pixels (M) | #RO/#Pixel ratio |
| 0&1 | 11 | 62.5 | 11 | 83 | 25 ² | 24.2 | 1312 | 5 ² | 605 | 0.632 |
| 2&3 | 22 | 125 | 12 | 333 | 25 ² | 105.6 | 1312 | 5 ² | 2640 | 0.158 |
| 4&5 | 22 | 125 | 18 | 333 | 25 ² | 158.4 | 1312 | 5 ² | 3960 | 0.158 |

VTX bkg hit occupancy (w. “CMOS”)

| Beam para. | 1000GeV-B1b_ws | | | | 1000GeV-A1 | | 500 GeV_ws | | | | LOI |
|------------|----------------|---------|---------|---------|------------|---------|------------|---------|-------------|---------|---------|
| DID | w. AntiDID | | no. DID | | w. AntiDID | | w. AntiDID | | w. AntiDID | | |
| Detector | ILD_O1_v02 | | | | | | | | ILD_00fwp01 | | |
| Sim. Stat. | 20Bx | | 20Bx | | 20Bx | | 7Bx | | 7Bx | | |
| Layer | Hits/BX | occ.(%) | Hits/BX | occ.(%) | Hits/BX | occ.(%) | Hits/BX | occ.(%) | Hits/BX | occ.(%) | occ.(%) |
| 0 | 6214 | 12.84 | 25821 | 53.35 | 2771 | 5.73 | 2132 | 2.93 | 2679 | 3.67 | 3.33 |
| 1 | 3334 | 6.89 | 14599 | 30.16 | 1525 | 3.15 | 1102 | 1.51 | 1674 | 2.30 | 1.90 |
| 2 | 1143 | 2.18 | 788 | 1.51 | 519 | 0.99 | 349 | 0.44 | 335 | 0.42 | 0.40 |
| 3 | 663 | 1.27 | 567 | 1.08 | 328 | 0.63 | 223 | 0.28 | 287 | 0.36 | 0.33 |
| 4 | 317 | 0.40 | 342 | 0.43 | 162 | 0.21 | 91 | 0.08 | 69 | 0.06 | 0.08 |
| 5 | 272 | 0.35 | 333 | 0.42 | 129 | 0.16 | 90 | 0.08 | 62 | 0.05 | 0.06 |

- Hit occupancies are estimated at 1 TeV and 500 GeV, with different det. config.
- 1 tracker hit = 4 pixel hits assumed. (9 pixel/hit might be used in LOI)
- 500 GeV case, ILD_00fwp01 results consistent with LOI values
ILD_O1_v02 is about 20~30% less than ILD_00fwp01 in L0&1.
- 1000 GeV : w. AntiDID is about x4 of 500 GeV
no DID/w.DID x4 more hits in 1st layer.
Note: # Pairs = 430k/BX(1TeV), 169k/BX(500GeV) → x 2.5
- Considering phi dep. Layer 0, ladder 3~5 have ~1/2 hits of 11 ladders.
→ Occupancy would be ~ 3 larger in these ladders

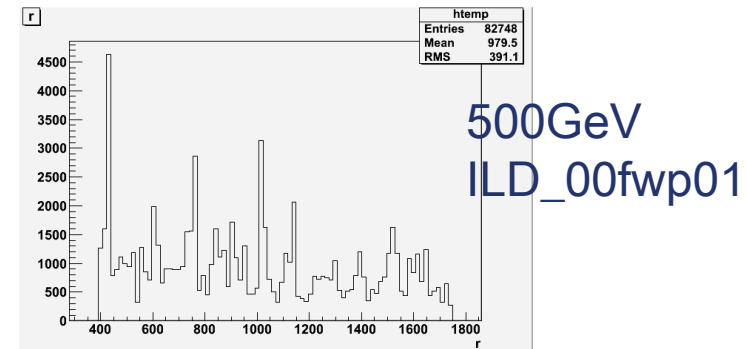
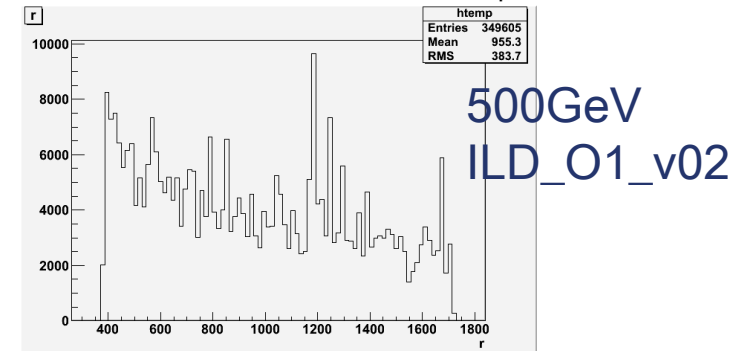
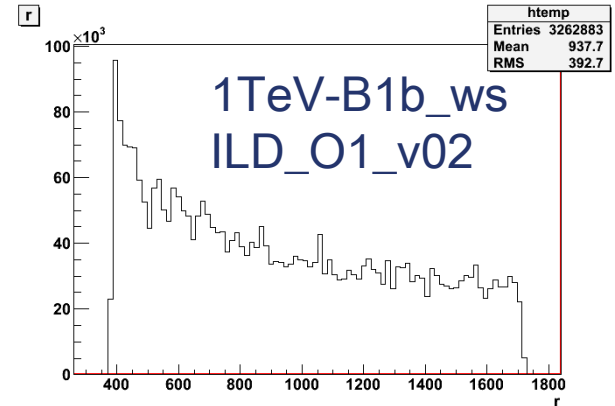
TPC hits

1 TeV-B1b_ws: 163k hits/BX (ILD_O1_V02)
-A1 : 78k hits/BX (ILD_O1_v02)
500 GeV : 50k hits/BX (ILD_O1_V02)
12k hits/BX (ILD_00fwp01)

1 TeV ~ 3 x 500 GeV hits

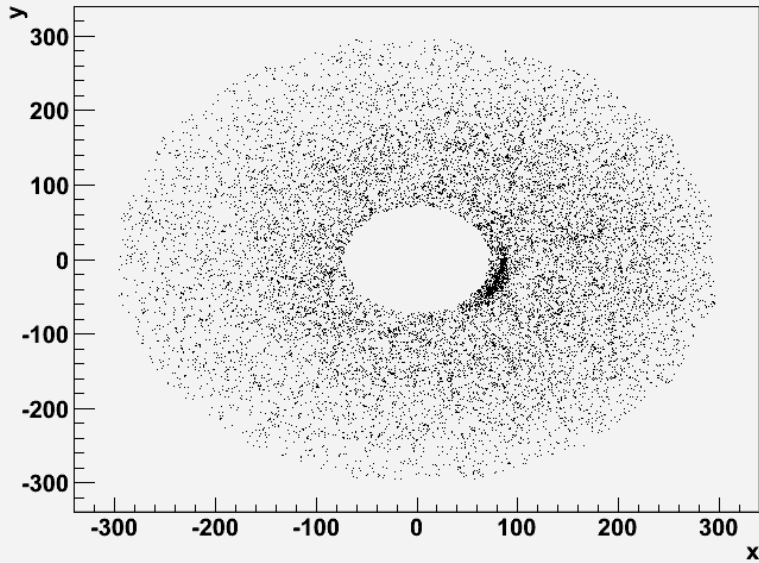
ILD_O1_V02 ~ 4xILD_00fwp01

geometry problem in ILD_O1_v02 ?

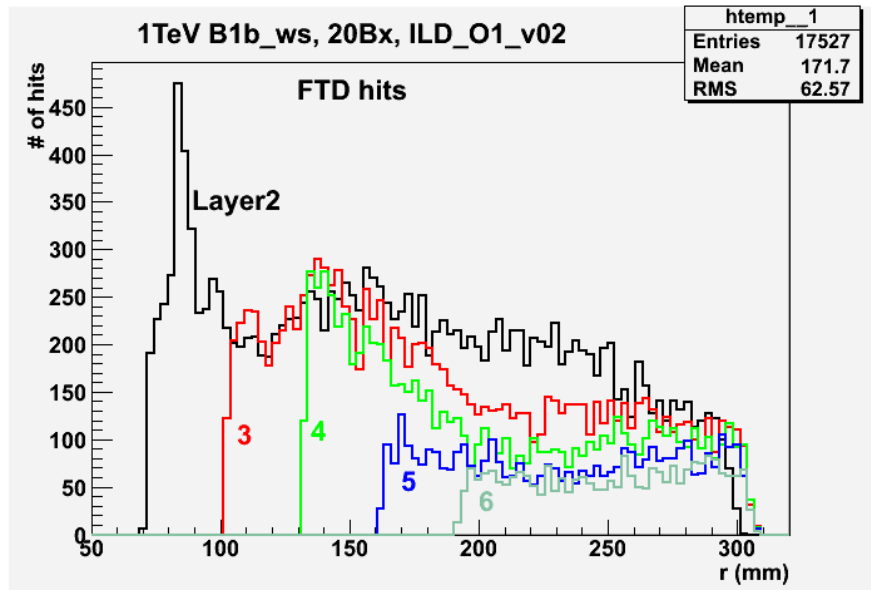
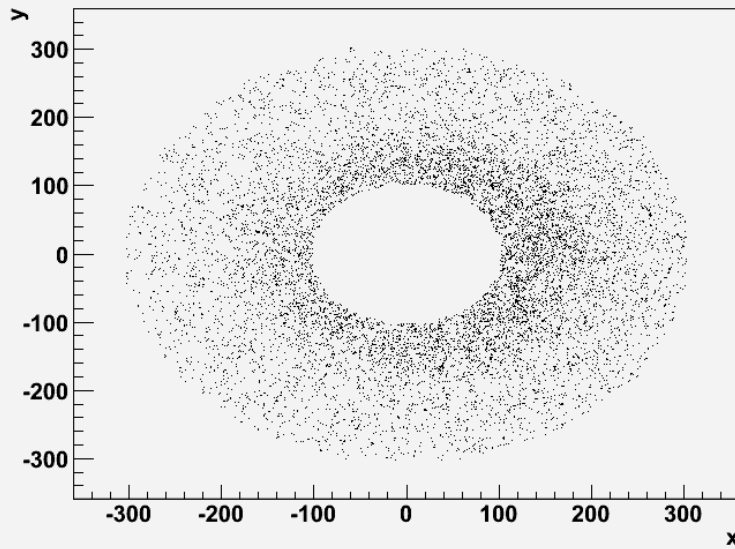


FTD Hits 1 TeV (ILD_O1_V02)

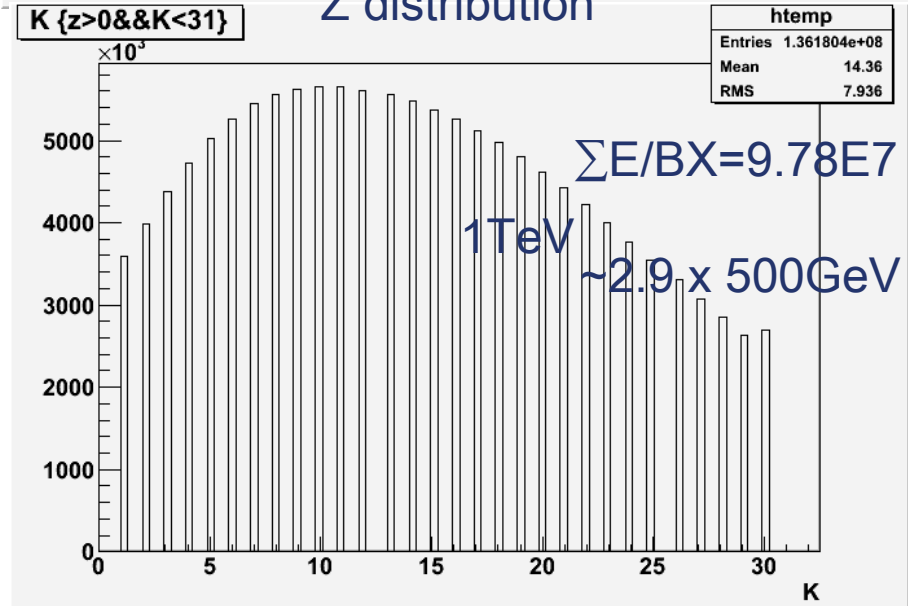
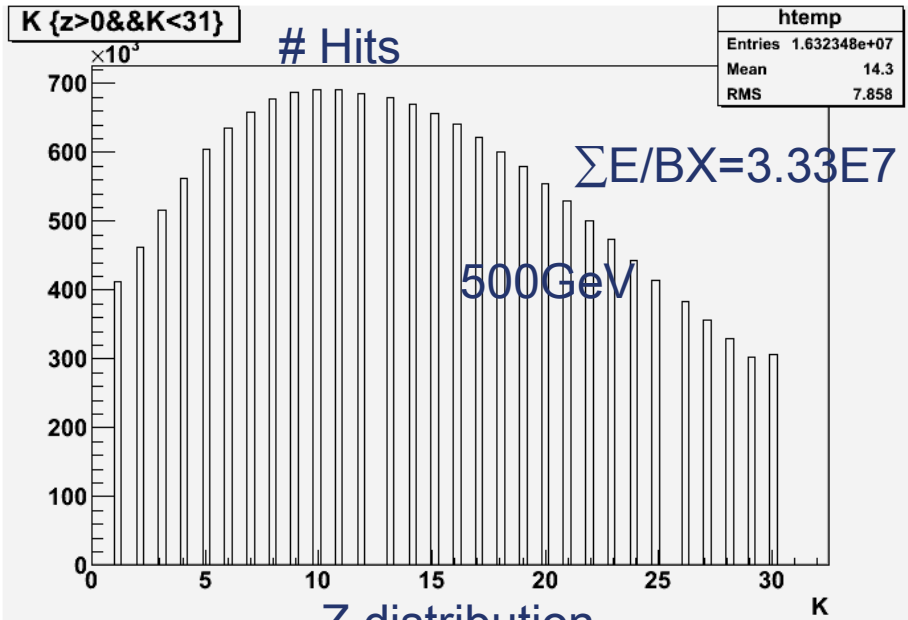
y:x {lay==2&&z>0}



y:x {lay==3&&z>0}



| Layer | #Hits/BX | | Ratio |
|-------|-------------|--------|-------|
| | 1TeV B1b_ws | 0.5TeV | |
| 0 | 0 | 0 | |
| 1 | 0 | 0 | |
| 2 | 876 | 270 | 3.24 |
| 3 | 619 | 191 | 3.24 |
| 4 | 407 | 123 | 3.31 |
| 5 | 202 | 56 | 3.59 |
| 6 | 126 | 37 | 3.37 |



Z distribution

Summary

- Background hit occupancies were studied
 - ◆ with the latest GDE beam parameters for 1 TeV and 500 GeV
 - ◆ ILD_O1_v02 (beam pipe geometry overlaps), Mokka-07-07-p06
- VXD
 - ◆ 500 GeV result is consistent with LOI result (assume 4pixels/hit)
 - ◆ CMOS like VXD,
 - Hit occupancy of SimTrackerHit at 1 TeV was about x4 of 500 GeV
 - Taking into account phi-dependence of hit distribution, the occupancy could be x3 larger
 - Faster readout is required.
 - ◆ FPCCD like VXD (smaller pixels, inter-pulse readout),
 - Occupancies at the inner layers would be higher.
- TPC, FTD, BCAL : 3~4 times more hits at 1 TeV-B1b
- 500 GeV ILD_O1_V02 : ~x3 more TPC hits than ILD_00fwp01
Geometry overlaps in beampipe may cause the difference

Backup Slides