A study of pair backgrounds

Preliminary study of pair background hits
with new ILD detector models
and
updates since KILC12

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KEK

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ILDWS

TDR beam parameter
http://ilc-edmsdirect.desy.de/ilc-edmsdirect/item.jsp?edmsid=D00000000965015

Center of mass energy	GeV	250	350	500	L upgrade 500	Ecm upgrade 1000 A1	1000 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 vertial 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	$\times 10^{34} cm^{-2} s^{-1}$	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

(~100 in RDR500)

1 TeV B1b_ws
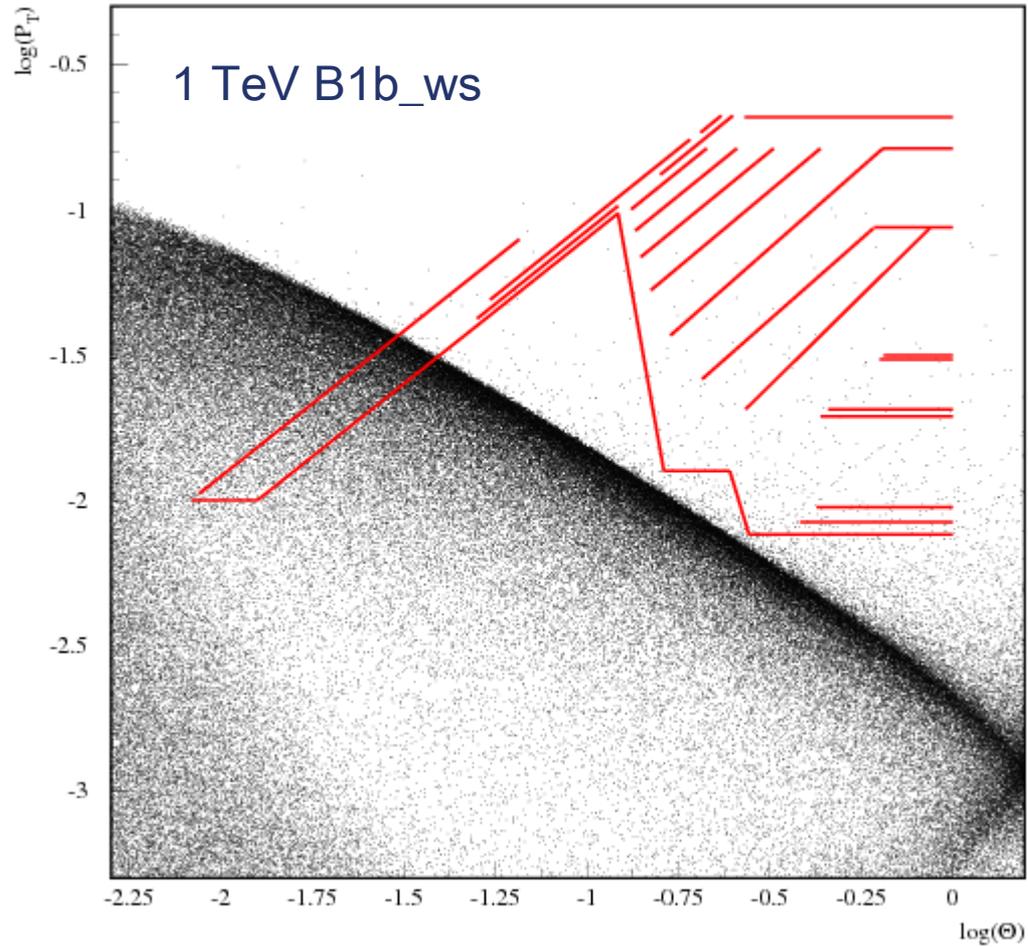
By Mikael Berggren

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, 1000_A1]_runX_waisty_190 20BX
  - Waisty_opt_Jan2012_500GeV_run9_waisty_250   7BX
  - RDR_500 …

- 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

  ILD_O1_v03 & ilcsoft-v01-13-06 (mokka-07-07-p08) - new

- 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


Overlap check by Ch.Grefe ILD_O1_v02

Overlaps
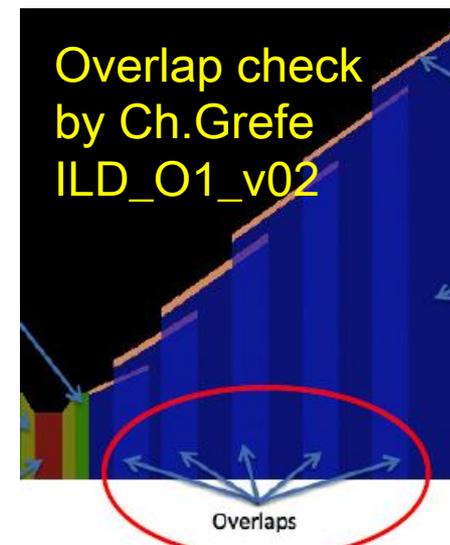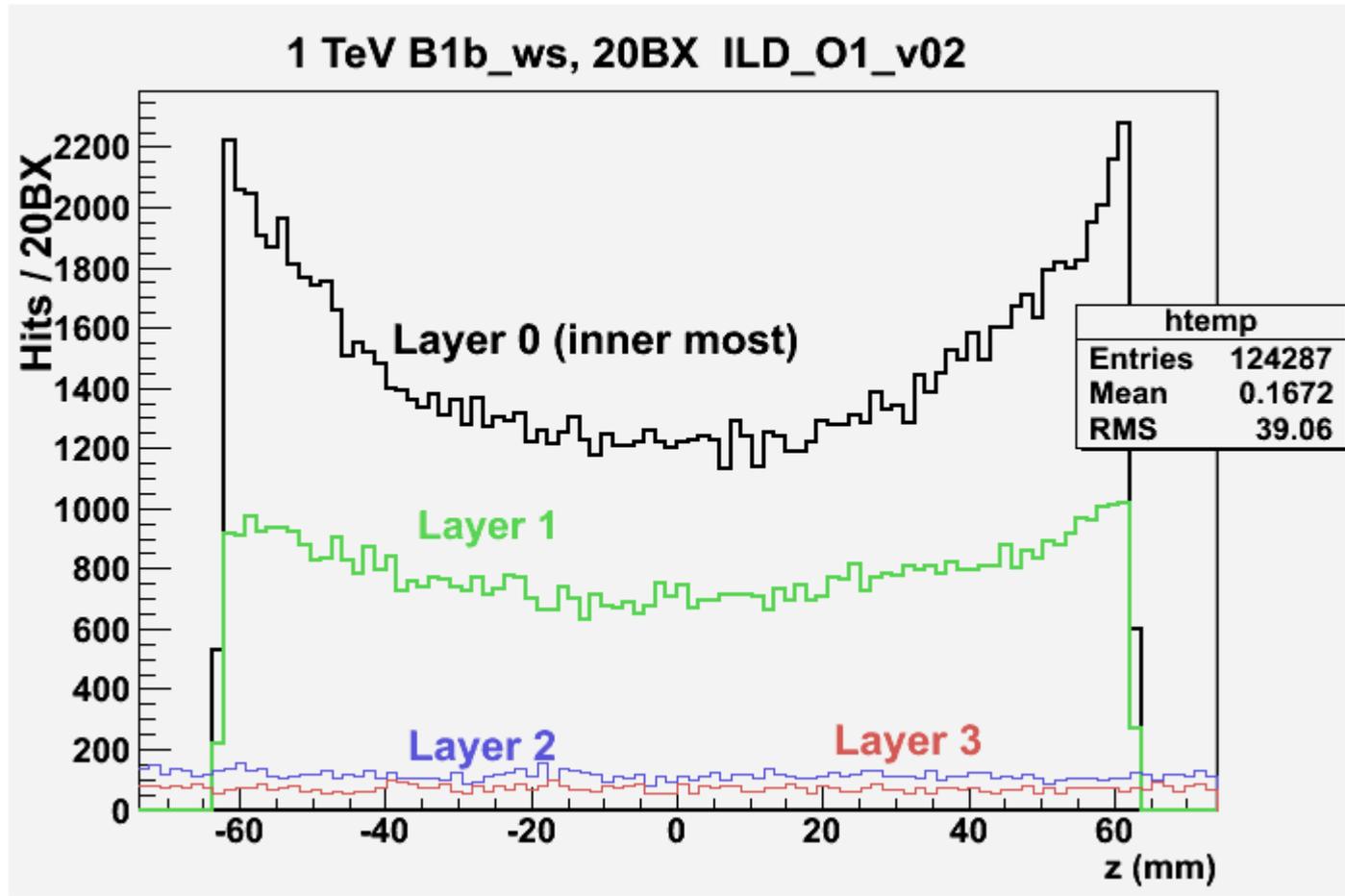
Z distribution

Phi dependence of VTX hits

1 TeV-B1b_ws

Number of hits/layer/20Bx — **1 TeV B1b_ws, 20Bx, ILD_O1_v02** — Layer 0, Layer 1, ladder number

Number of hits per ladder per 20Bx — **1 TeV B1b_s, 20Bx, ILD_O1_v02** — Layer 2 & 3, Layer 2, Layer 3, ladder number

Number of ladder hits/20Bx/ladder — **1 TeV B1b_ws, 20Bx, ILD_O1_v02** — Layer 4 & 5, Layer 4, Layer 5, ladder number
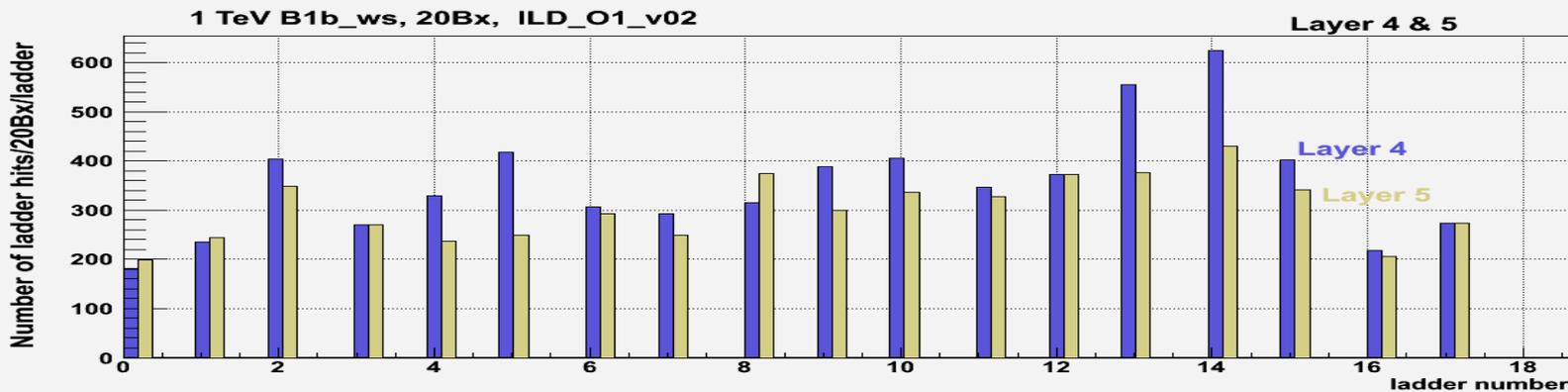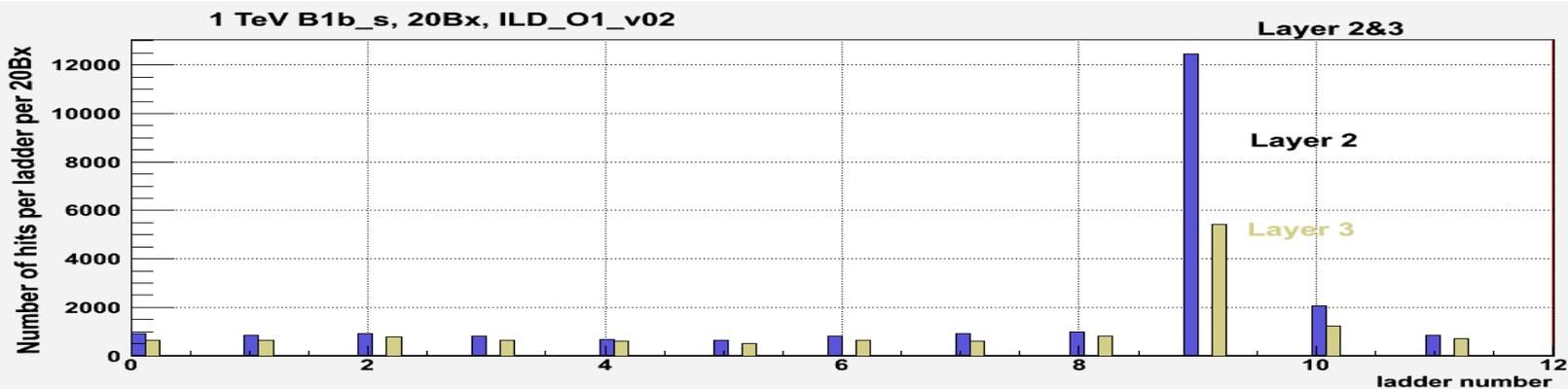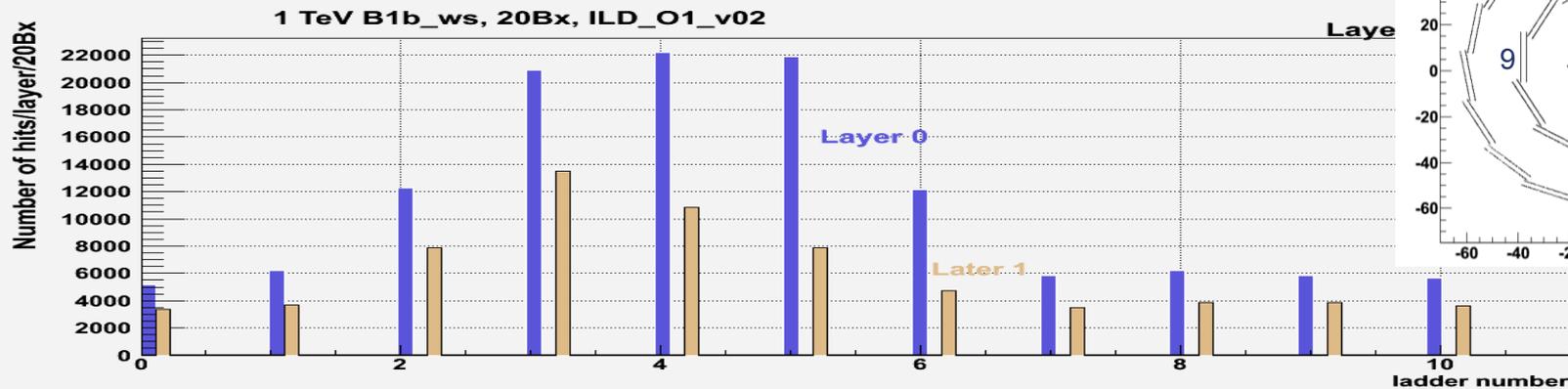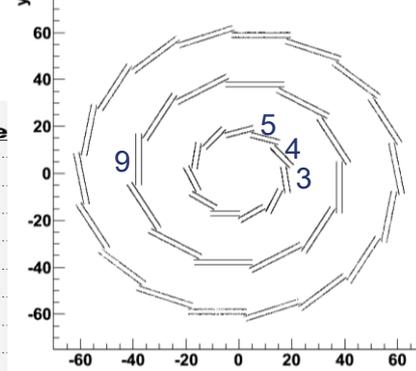
Layer 2 ladder 9:
   Z distribution of ladder 9 is similar to layer0 ladders.
   Many hits due to back scattering ?
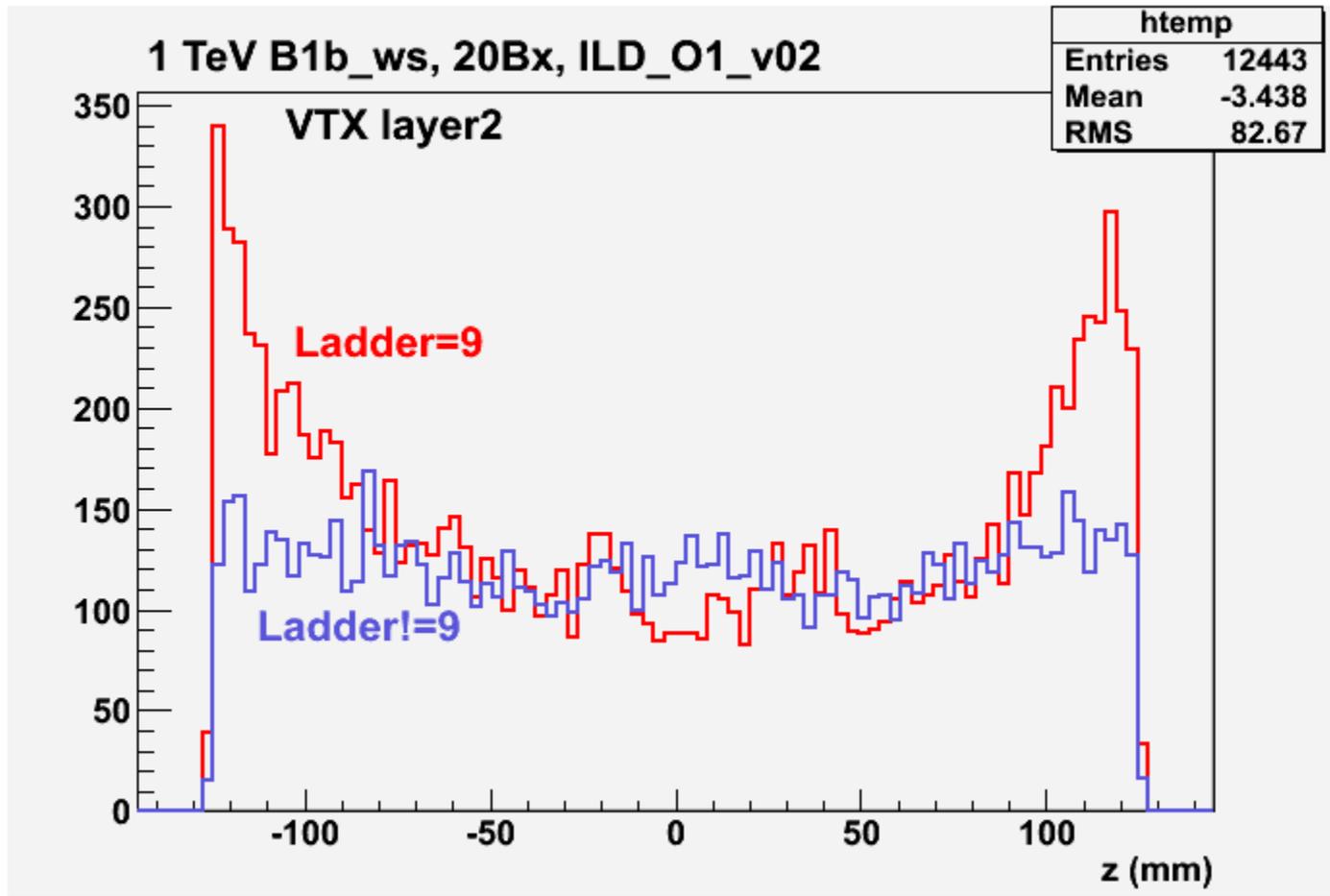
VTX geometry to calculate hit occupancy

■ 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			
	Type 1 layer0&1		46 usec
	layer2,3,4,5		184 usec
	Type 2		inter-pulse

1 TeV   Number of bunches   2450
        bunch separation   366 nsec

| Layer | Width (mm) | HalfL (mm) | #Ladder | Type1 | | | Type2 | | | Type2/Type1 |
				#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 | Type1 | | | Type2 | | | Type2/Type1 |
				#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

Pixel occupancy

- Pixel occupancy for 1train.
  - cut : signal e- > 200 e- /pixel
  - ~5 times greater than sb2009wTF-500 (# BX is different)

Layer	1TeV Without cut	1TeV With Cut	Sb2009wTF-500 w/ cut
1	20.1 %	15.5 %	3.079 %
2	10.1 %	7.79 %	1.74 %
3	0.854 %	0.674 %	0.0919 %
4	0.458 %	0.363 %	0.0731 %
5	0.145 %	0.116 %	0.017 %
6	0.116 %	0.094 %	0.015 %

This study

KILC 12   April 25. 2011

by D.Kamai @ KILC12

TPC SimTracker hits
  1 TeV-B1b_ws : 163k hits/BX (ILD_O1_v02)
          -A1   :   78k hits/BX (ILD_O1_v02)
  TDR- 500 GeV :   50k hits/BX (ILD_O1_v02)
                        49k hits/BX (ILD_O1_v03)
                        12k hits/BX (ILD_00fwp01)
  RDR_500   :   7k hits/BX (ILD_O1_v02)

   1 TeV ~ 3 x 500 GeV hits
    ILD_O1_V02 ~ 4xILD_00fwp01

1TeV-B1b_ws
ILD_O1_v02

500GeV
ILD_O1_v02
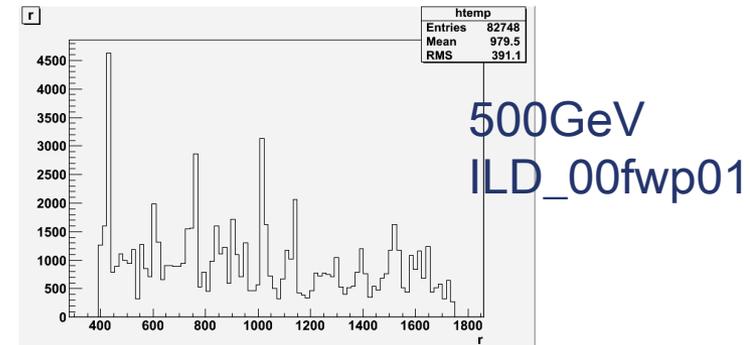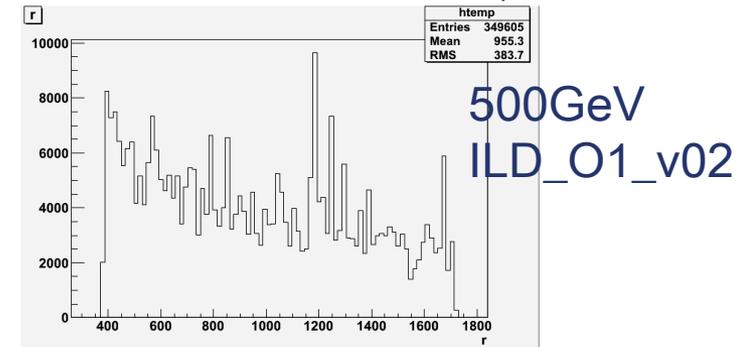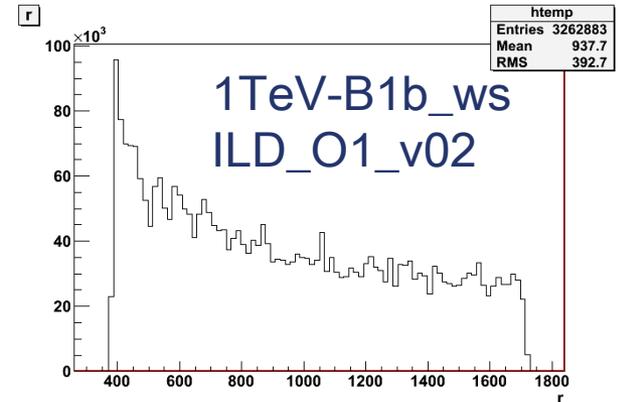
500GeV
ILD_00fwp01

# FTD Hits 1 TeV   (ILD_O1_V02)

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

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

1TeV B1b_ws, 20Bx, ILD_O1_v02

htemp___1	
Entries	17527
Mean	171.7
RMS	62.57

FTD hits

Layer2

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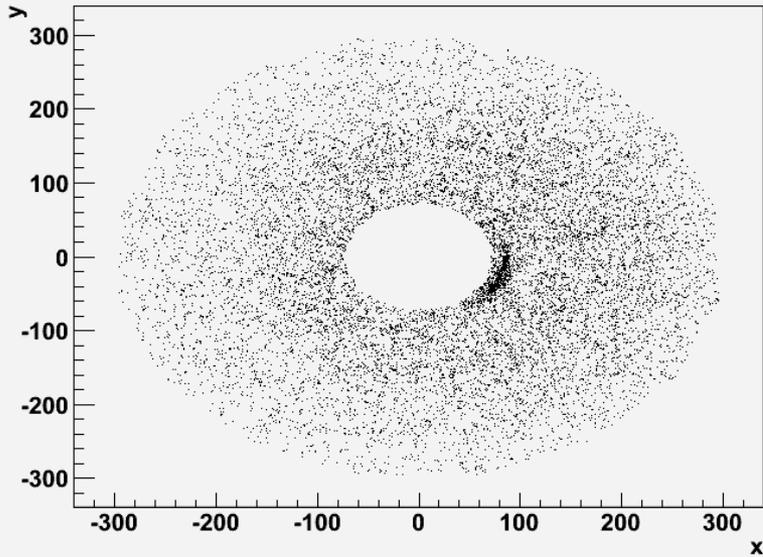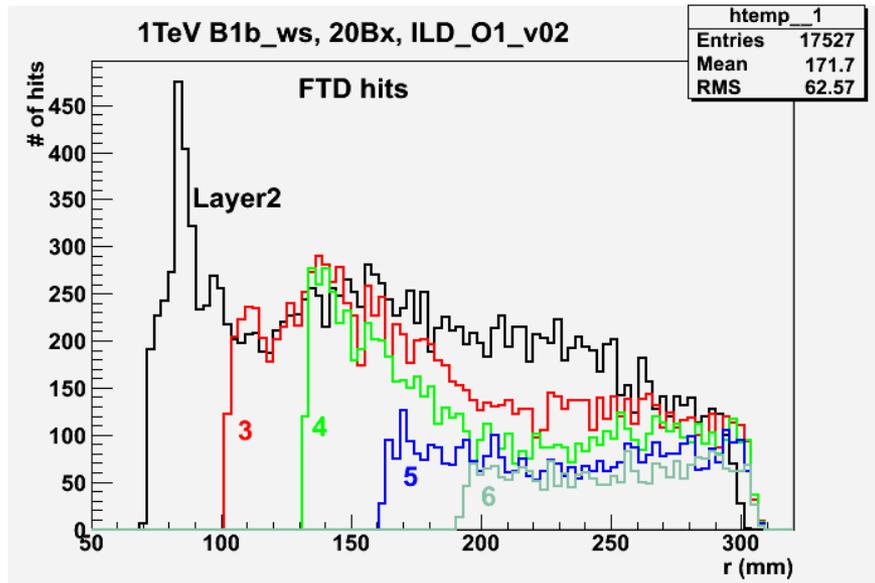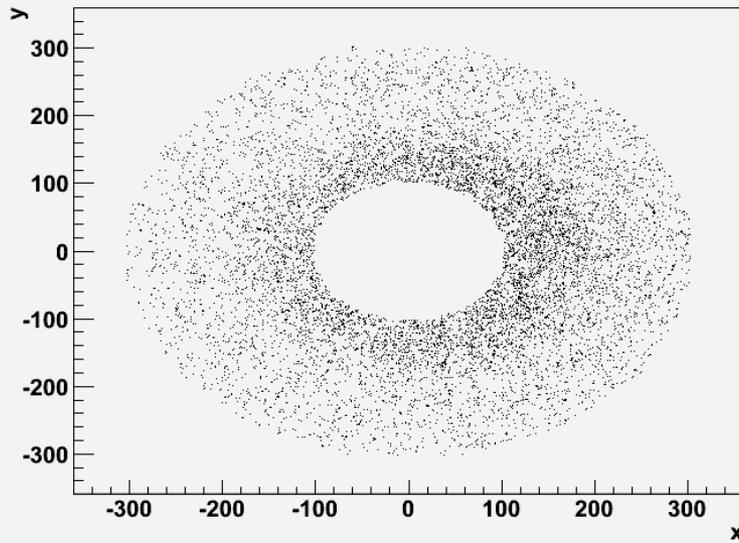
Layer	#Hits/BX		Ratio
	1TeV B1b_ws	TDR 0.5TeV	
0	0	0	
1	0	0	
2	876	270	3.24
3	619	191	3.24
4	407	123	3.31
5	202	56	3.59
6	126	37	3.37

Radial Energy Deposition

TDR 1TeV_B1b_ws
ILD_O1_v02

TDR 500GeV_ws
ILD_O1_v02
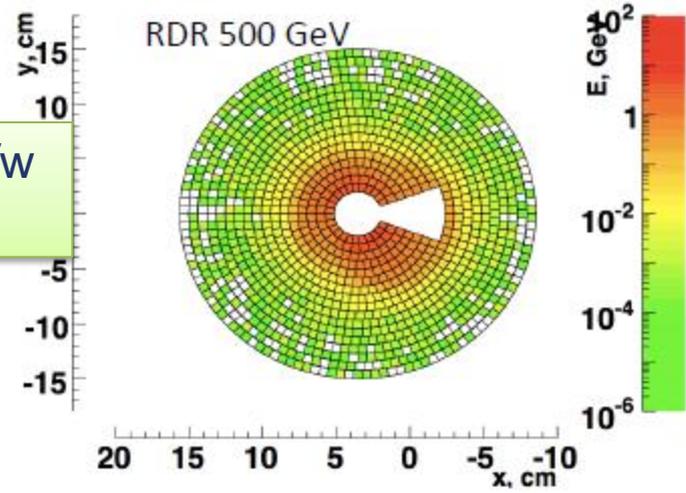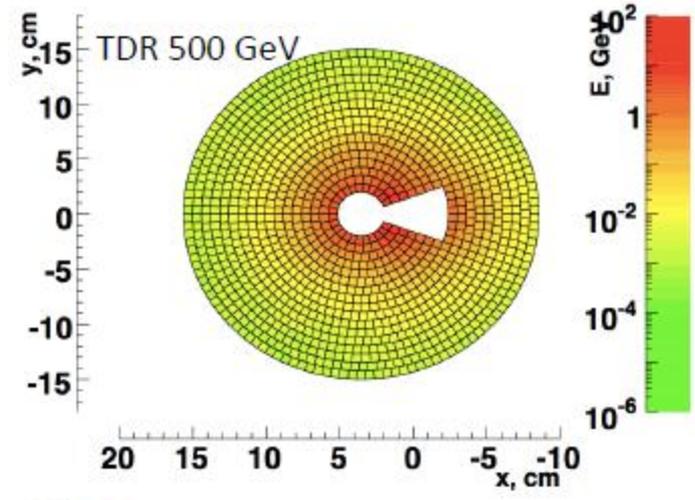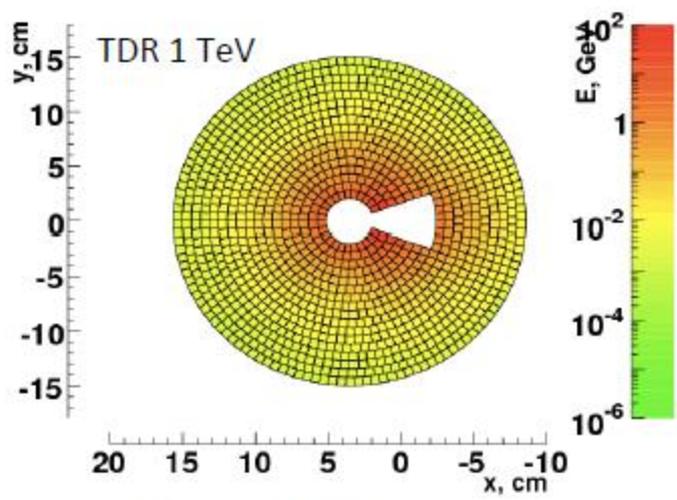
RDR 500 ILD_00fw
(before LOI)

One BeamCal, energy
deposition/ 8mm x 8mm,
per BX

5/22/12

By Aura Rosca

Longitudinal Energy Deposition

TDR 1TeV_B1b_ws
ILD_O1_v02

TDR 500GeV_ws
ILD_O1_v02

RDR 500 ILD_00fw
(before LOI)

TDR 1 TeV

E_{tot} = 8042 GeV

TDR 500 GeV

E_{tot} = 2183 GeV

RDR 500 GeV

E_{tot} = 186.4 GeV
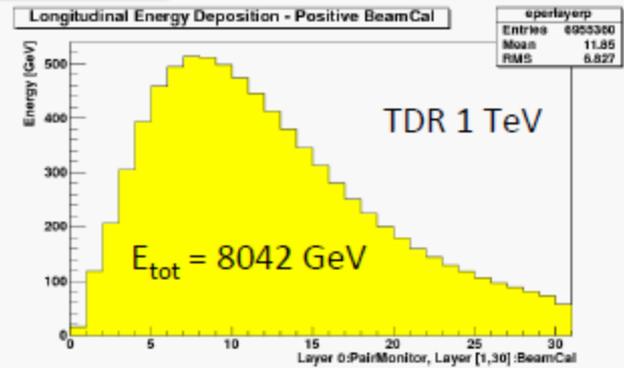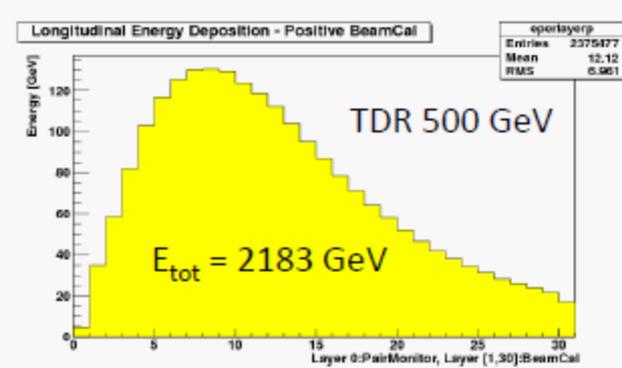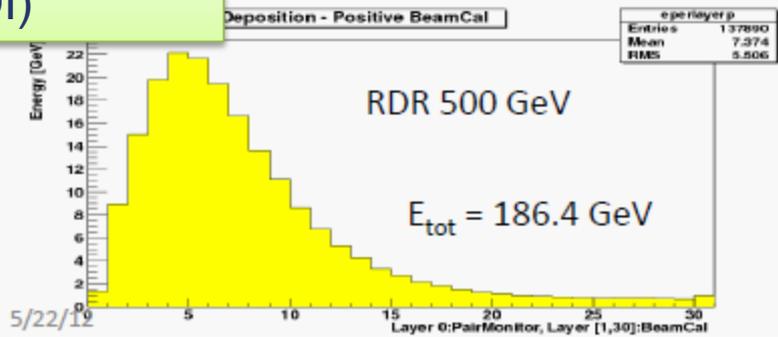
Pairs are harder for
the TDR beam parameters.

5/22/12

Aura Rosca - Bcal Pair Background Studies   8

Aura Rosca

Time dist. of VTX hits
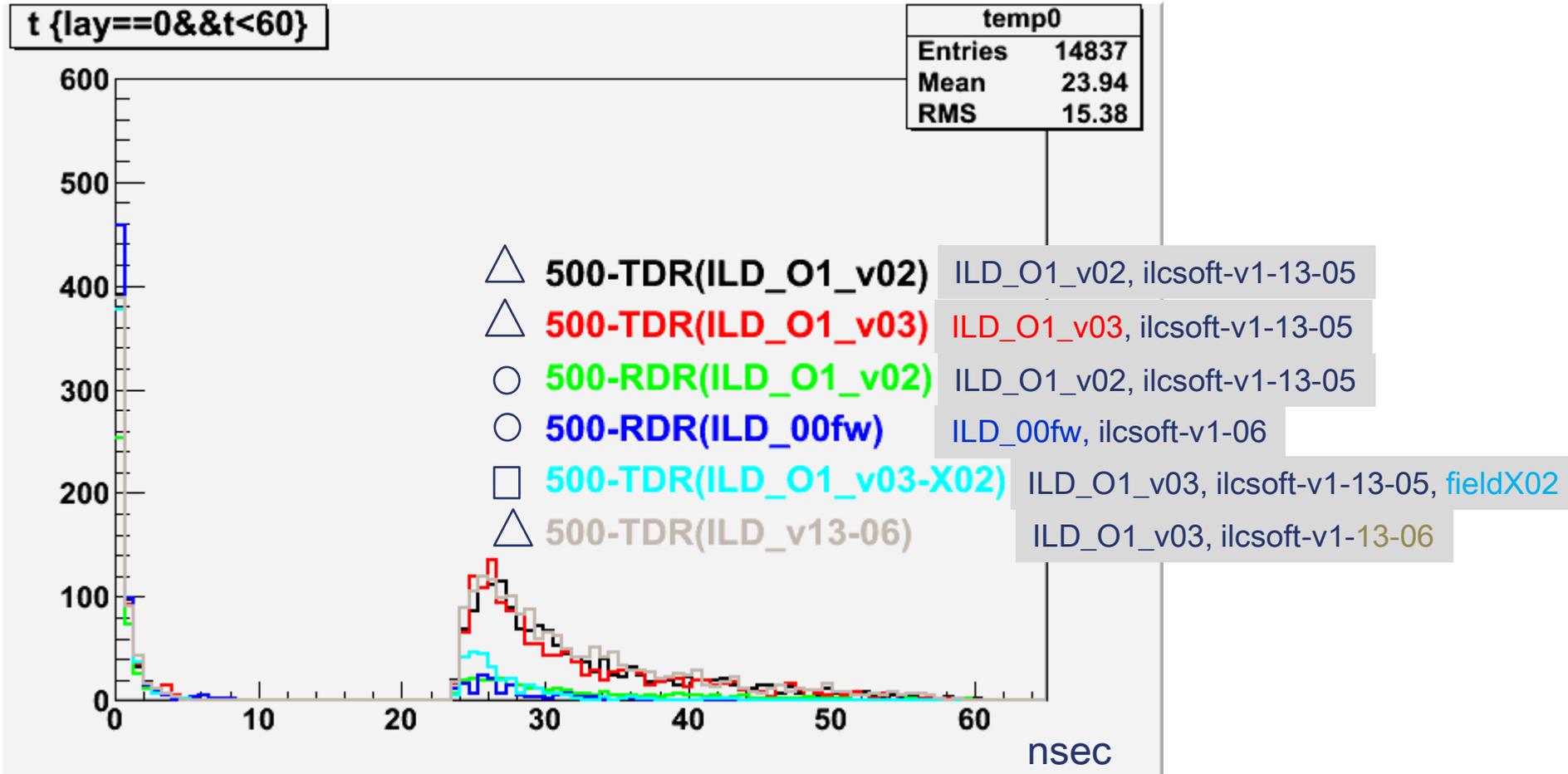
Back scattering from 3.6m (= 24nsec x c/2)

Direct hits vs Backscatter

	Detector	ilcsoft	FieldMap	Mokka	Layer0 Hits/BX		
					t<20ns	t>20ns	(t>20)/(t<20)
500-TDR	O1_v02	v01-13-04	fieldX03	07-07-p06	557	1576	2.83
	O1_v03	v01-13-05	fieldX03	07-07-p07	568	1490	2.62
	O1_v03	v01-13-06	fieldX03	07-07-p08	563	1800	3.20
	O1_v03-X02	v01-13-05	fieldX02	07-07-p07	541	305	0.56
500-RDR	O1_v02	v01-13-04	fieldX03	07-07-p06	382	322	0.84
	ILD_00fw		fieldX02	06-07-p02	650	150	0.23

- No difference between ILD_O1_V02 and ILD_O1_V03
- TDR/RDR (ILD_O1_V02)
  - direct hits (t<20ns) x 1.5, back scattering (t > 20ns) x 4.8

- 500-RDR (ILD_00fw)
  - /grid/ilc/mc2008_2/simulated/ILD_00/pair_bkgs_nominalparams_cms500/pairs_nominal_500GeV_runXX
 - Total rate of ILD_O1_V02 is similar to ILD_00fw, but direct/backscattering ratio is different.

	ILD_00fw	ILD_O1_V02
FieldMap	fieldX02	fieldX03
TPCCut	10kev	0kev
range cut	0.2mm	0.1mm
userDeltaIntersection	default	1e-5mm
userDeltaOneStep	default	1e-4mm
PhysicsList	LCPHYS	QGSP_BERT

Anti-DID field

Field map(ZX-FieldX03: Z vs X)

FieldX03

7mrad line

BCAL hole
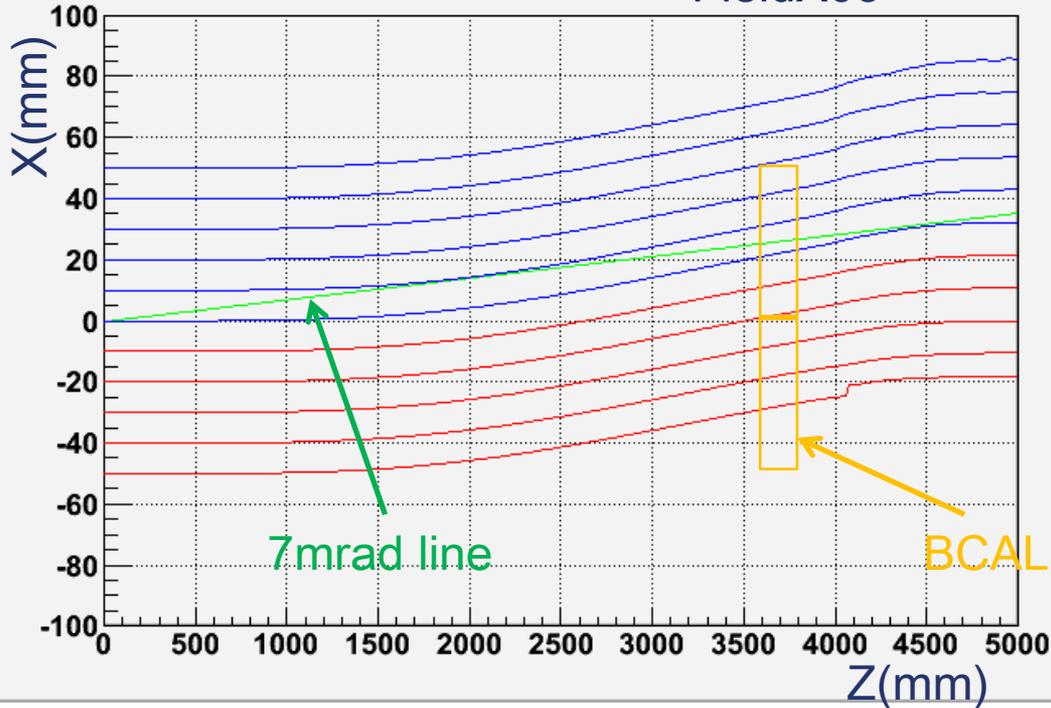
Field map(ZX-FieldX02: Z vs X)

FieldX02 not good.
used in old samples)

Z(mm)
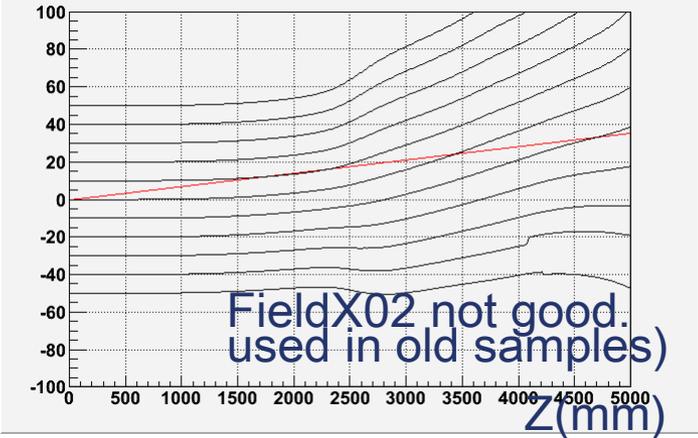
Field map(ZY-FieldX03: Z vs Y)

Z(mm)
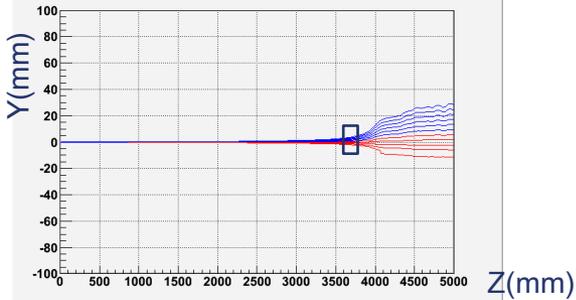
y:x {K==1&&z>0}
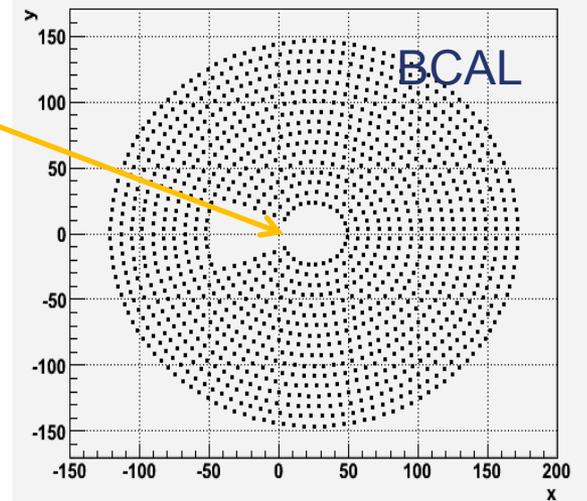
BCAL

BCAL absorber geometry
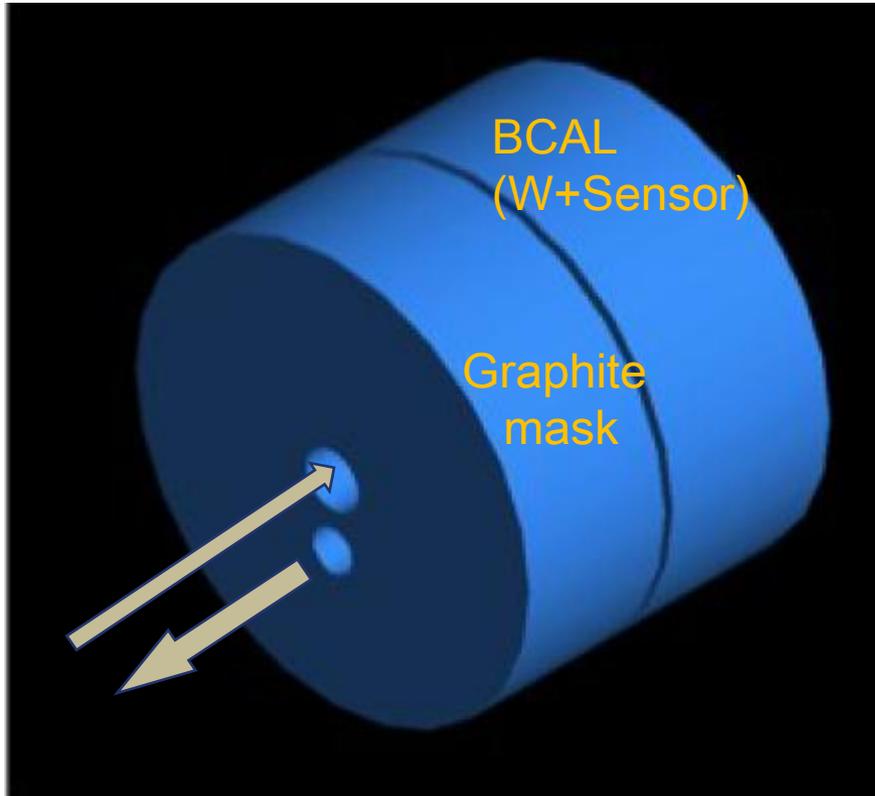
Summary

- Background hit occupancies were studied with the recent codes
- VXD
    - 500 GeV result is consistent with LOI result (assume 4pixels/hit)
    - Type 1 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.
    - Type 2 VXD (smaller pixels, inter-pulse readout),
        - Occupancies at the inner layers would be higher.
- Background hits in TPC, FTD, BCAL   are increased
- Possible source of increased backgrounds would be
    - More pairs with the TDR parameter than the RDR parameter
    - Material near beam pipe in BCAL

Backup
Slides