Beam pair-background in with SB2009 and RDR

Mikael Berggren[1]

[1]DESY, Hamburg

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Outline

- The SB2009 issues.
- Reminder: Beam-strahlung.
- Simulation.
- RDR $\rightarrow$ SB2009
  - VTX
  - Other detectors.
  - BeamCal & LumiCal
- Conclusions.

This is all work-in-progress. Exact numbers might change.

The issues

- Positron source → luminosity below 300 GeV.
- Larger incoming beam-energy spread at 500 GeV (but smaller at 250).
- Changes to BDS → muon background.
- More beam-strahlung.

A commite set up by RD to communicate between the concepts and GDE on physics impacts. Chair Jim Brau. Members: T. Markiewicz,S. Boogert,T. Barklow, N. Graf, M. Thomson, K. Büsser, K. Fujii, D. Miller, A. Miyamoto, T. Maruyama, M.B.

Beam-strahlung in 1.5 slides

Due to the very strongly focused beams, the fields (both E and B) has a large bending power on the other beam. Consequences:

- Primary beam is focused by the other beam.
- Strong bending $\rightarrow$ much synchrotron radiation. Widens the distribution of the primary $e^{\pm}$ energy.
- Photons
  - ... get Compton-backscattered $\rightarrow$ photon component of beam, long tail to lower energies for the $e^{\pm}$.
  - ... interact with photons (synchrotron ones, or virtual ones) in the other beam $\rightarrow$ $e^{\pm}$-pairs.
- So, there will be a component of $e^{\pm}$ with the *opposite* charge to that of its parent beam.
- These gets *de-focused*: The pair background

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The wrong-sign $e^{\pm}$:s gets a maximum kick if they are at the outer edge of the beam.
The kick is independent of the (longitudinal) momentum of the particle.

p_T and θ anti-correlates, and accumulate at the edge.

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To study the effect, also draw the detector in these coordinates:

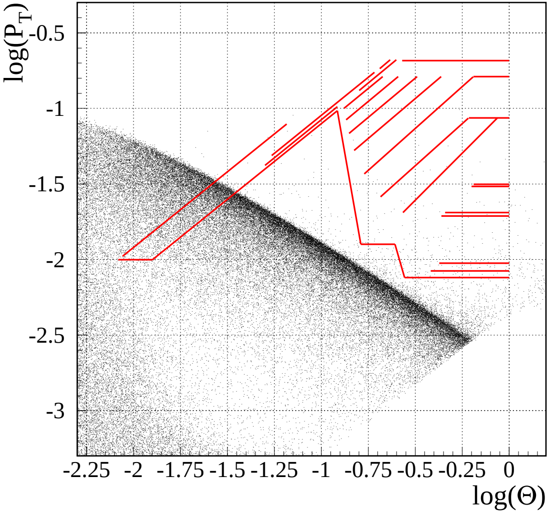
Place it at the p_T-θ corresponding to the p_T and θ a particle should have to turns back at the radius and z of the detector.
Note that that means that the detector moves with the B-field !

Pairs simulation

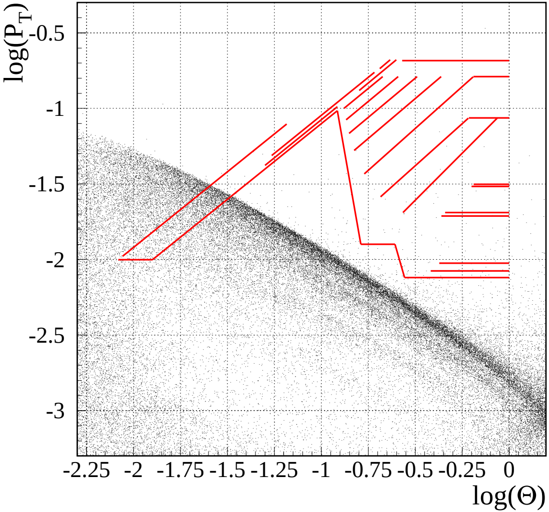
- Pairs generated by GuineaPig
- Beam-parameters:
  - SB2009 LowP with travelling focus. 213000/BX.
  - SB2009 LowP without travelling focus. 211000/BX.
  - RDR nominal. 124000/BX.
  - RDR LowP. 214000/BX.
  - Exact numbers might vary with GP settings !
- Full Mokka simulation for the tracking-aspects.
- For BeamCal: Stand-alone detector simulation or analytical transport - both with Anti-DID & crossing-angle.

Work by A. Hartin, K. Winchmann, K. Yoshida, A. Miyamoto, O. Novgorodova, M. B. ...

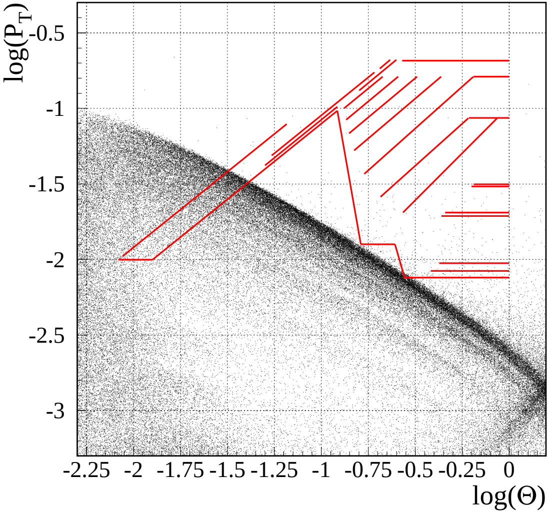
Pairs in tracker: SB2009-TF (no Xing angle, anti-DID)



Pairs in tracker: RDR nom (no Xing angle, anti-DID)

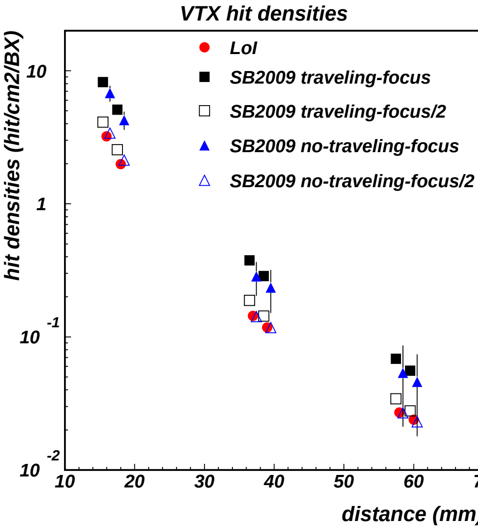


Pairs in tracker: RDR LowP (no Xing angle, anti-DID)



Tracking: Hits in Vertex detector

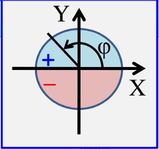
- Full simulation (Mokka), with crossing-angle and anti-DID field.
- No reconstruction yet, just count hits.
- The ILD VTX integrates of a certain time-window → only half as many BX:es with lowP !
- SB2009 no TF = RDR nom; SB2009 with TF = 1.3 × RDR nom.
- Some issues about the absolute numbers (GEANT4 settings) to be ironed out. Relative should be OK.



Tracking: Hits in Vertex detector

φ distribution

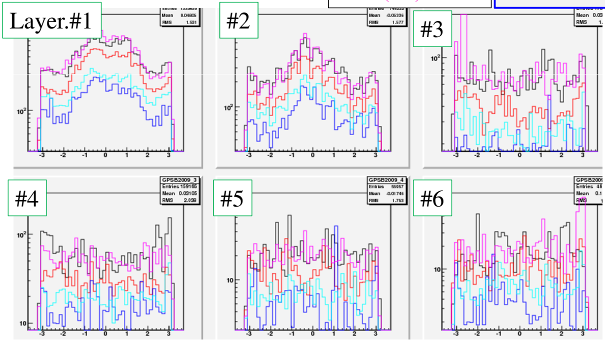
Definition of φ



SB2009wTF(GP)
SB2009wTF(cain)
Nominal(GP)
Nominal(cain)
LowP(GP)

φ distribution of hit was checked.

- Normalized to 1BX.
- Many background hits are at φ=0.



Tracking: Other detectors

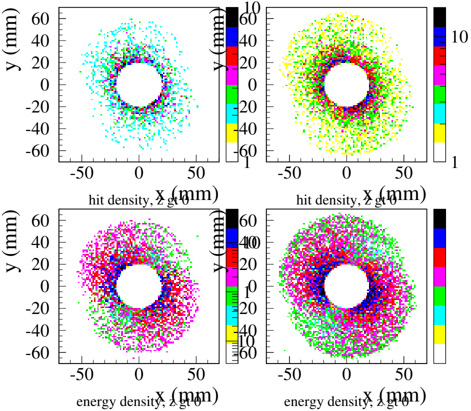
SB2009 TF and NTF

detector	LoI	SB09 Low P NTF	factor	SB09 Low P TF	factor
SIT (den.)	0.017+-0.010	0.039+-0.022	2.3	0.046+-0.016	2.7
	0.004+-0.0026	0.0088+-0.0030	2.2	0.013+-0.008	3.3
FTD (den.)	0.0127	0.0240	1.9	0.031	2.5
	0.0085	0.0170	2	0.021	2.5
	0.0017	0.0036	2.1	0.0045	2.6
	0.0018	0.0039	2.2	0.0050	2.8
	0.0014	0.0027	1.9	0.0036	2.6
	0.0008	0.0019	2.4	0.0026	3.2
	0.0007	0.0018	2.6	0.0025	3.6
HCAL (hits)	8419 +-649	19998+-374	2.4	25020+-621	3
ECAL (hits)	155.0	386.0	2.5	501	3.2
TPC (hits)	408.0	1026.0	2.5	1275	3.1
SET (hits)	5.6	13.4	2.4	15.5	2.8
	6.0	14.7	2.5	16.7	2.8

13.01.2010 VTX Hit Densities for Low P 3

BeamCal

- Only GP, but with crossing-angle and anti-DID.
- Both hit-densities (top) and energy-density (bottom) matters.
- The issue: can one still see a $\approx$ 250 GeV electron from a $\gamma\gamma$ process over the pairs-background in SB2009TF (right, RDR nom left)?
- Radius vs. Energy.
- SB2009TF extends 5 mm further, and has more pairs and more energetic ones.



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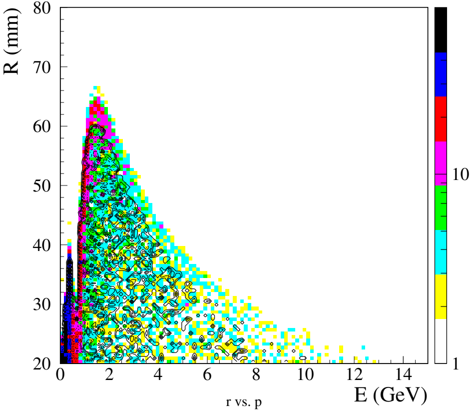
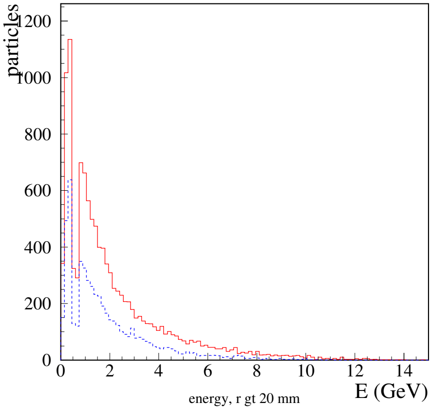


BeamCal

- Distribution of particle energy for r $>$ 20 mm.
- Total energy in BeamCal per BX: 24 TeV for SB2009TF, 10 TeV for RDR nom.
- Number of particles per BX: 11500 for SB2009TF,5400 for RDR nom.
- Energy density vs Radius: SB2009TF has about twice at any given radius, and extends 5 mm further.
- All the relevant numbers double



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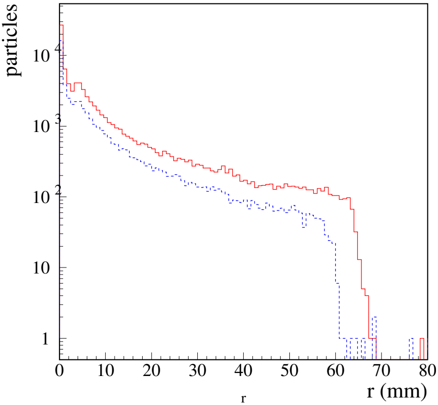

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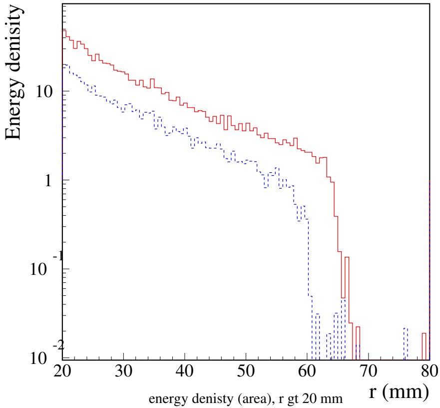

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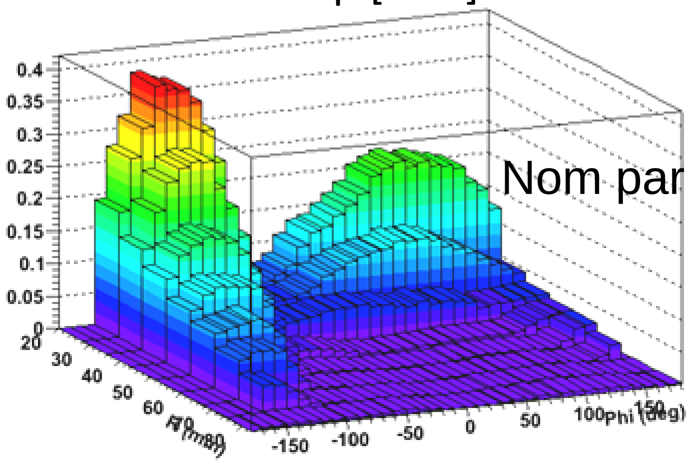
Detailed full simulation is on-going @ DESY-Zeuthen. (Some examples follows) The implications for the fundamental question on electron-tagging by this doubling will therefore be clarified soon.

Mean value Edep [GeV]



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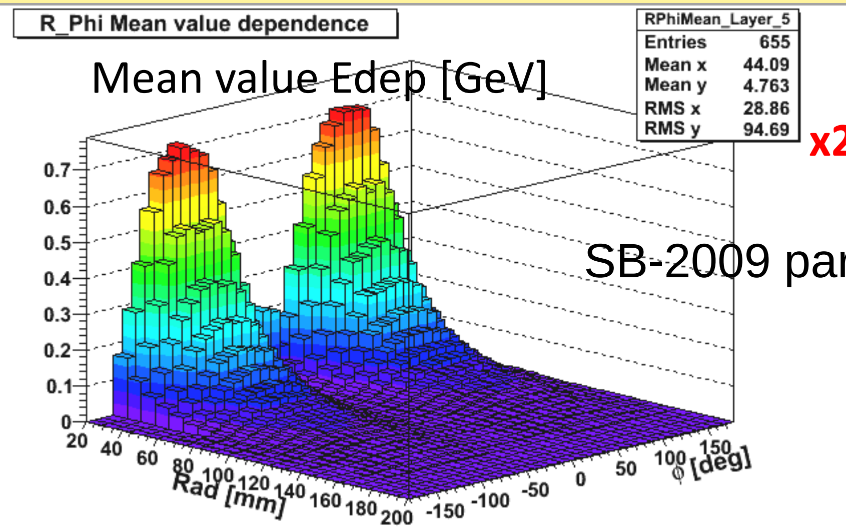
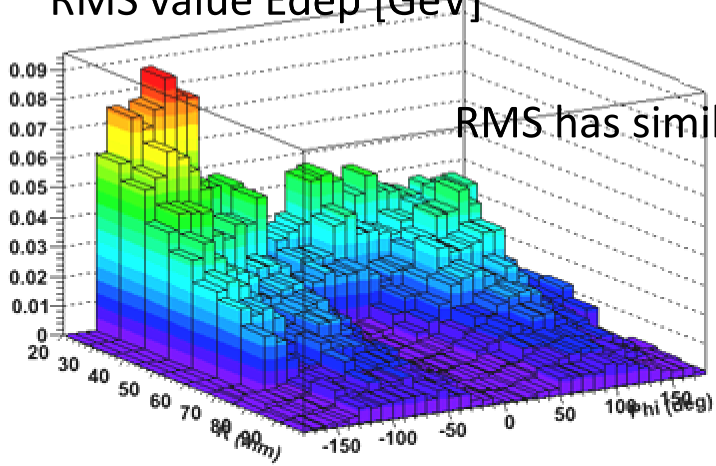


R-Phi segmentation examples for 6-th layer for nom and SB-2009 par (40 BX)

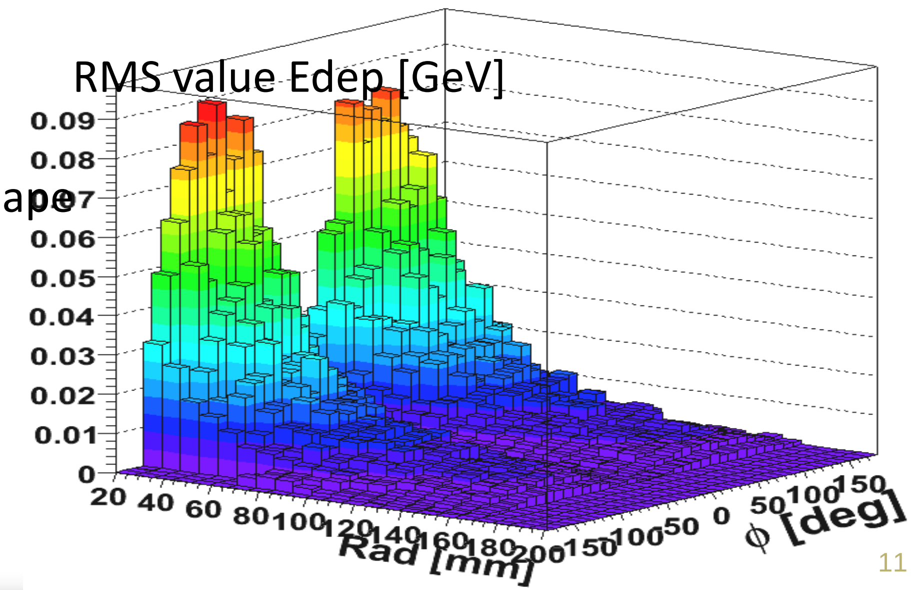
Nom: RMS<0.09GeV (max dep=0.38GeV)
SB2009: RMS<0.09GeV (max dep=0.72GeV)
sHEe: Maximal deposited energy in 8mm ring is ~ 0,37GeV

RMS value Edep [GeV]

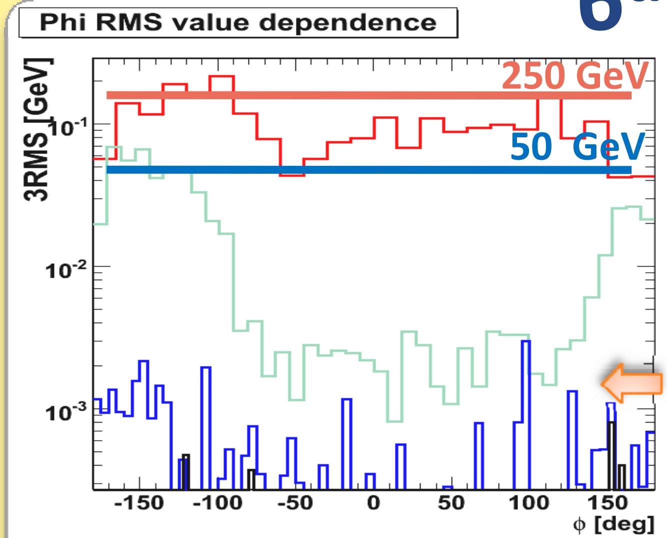


RMS has similar shape

RMS value Edep [GeV]

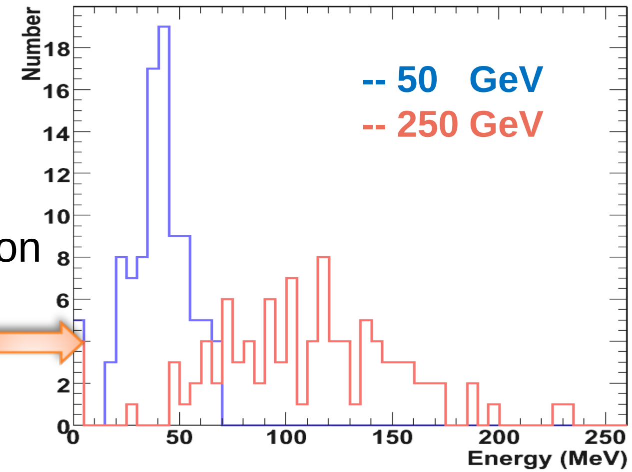


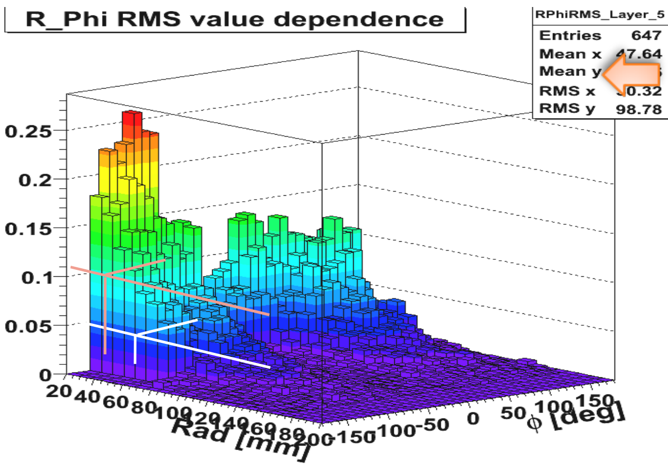
6th Layer (Nominal parameters)



For 8*8 mm^2 segmentation
Background

sHEe





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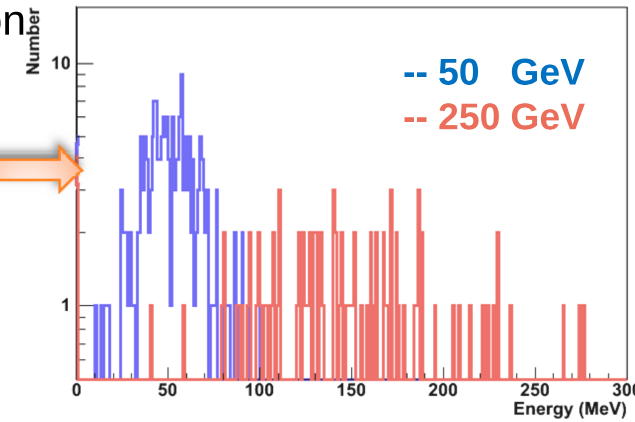
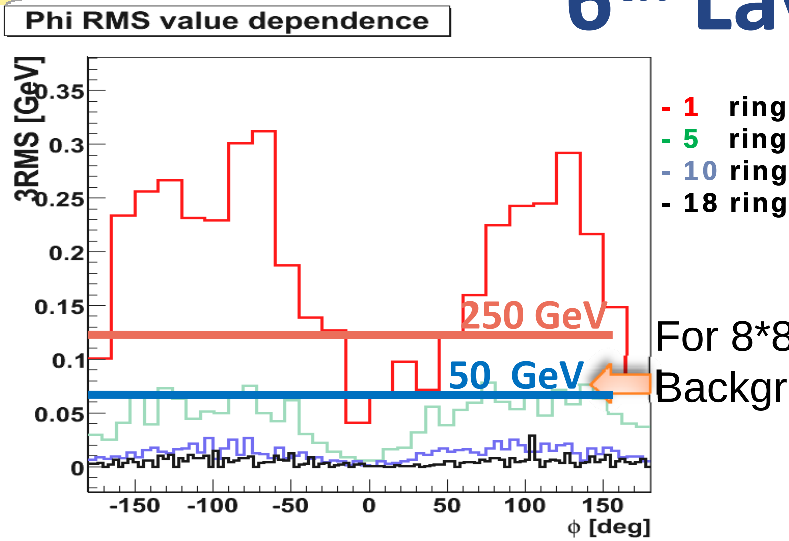


50 GeV: R-Phi – have a good probability after 6 ring, for the square segmentation after 5-th ring.

250 GeV: R-Phi – have good probability after 3 ring, for the square segmentation after 1-th ring.

6^{th} Layer (SB-2009 parameters)



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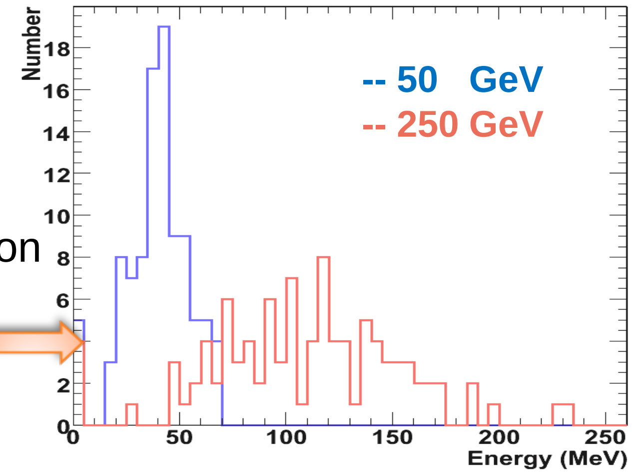
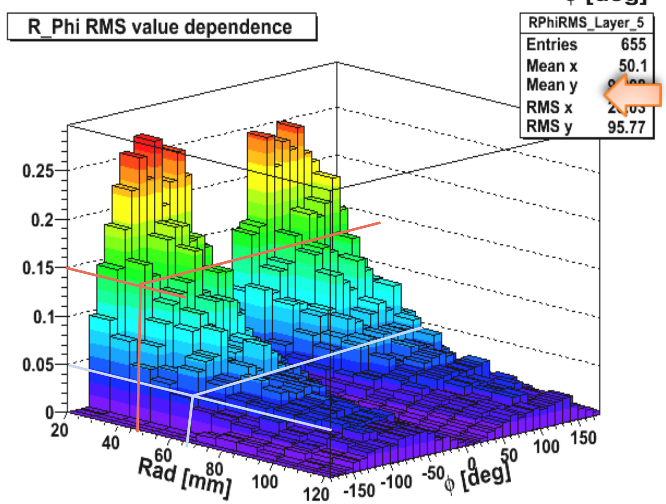
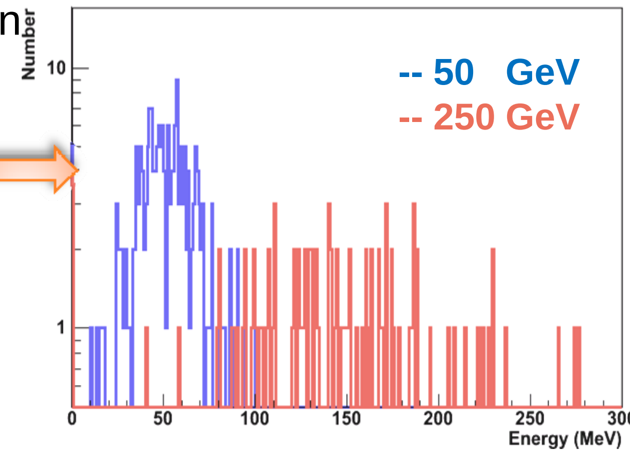




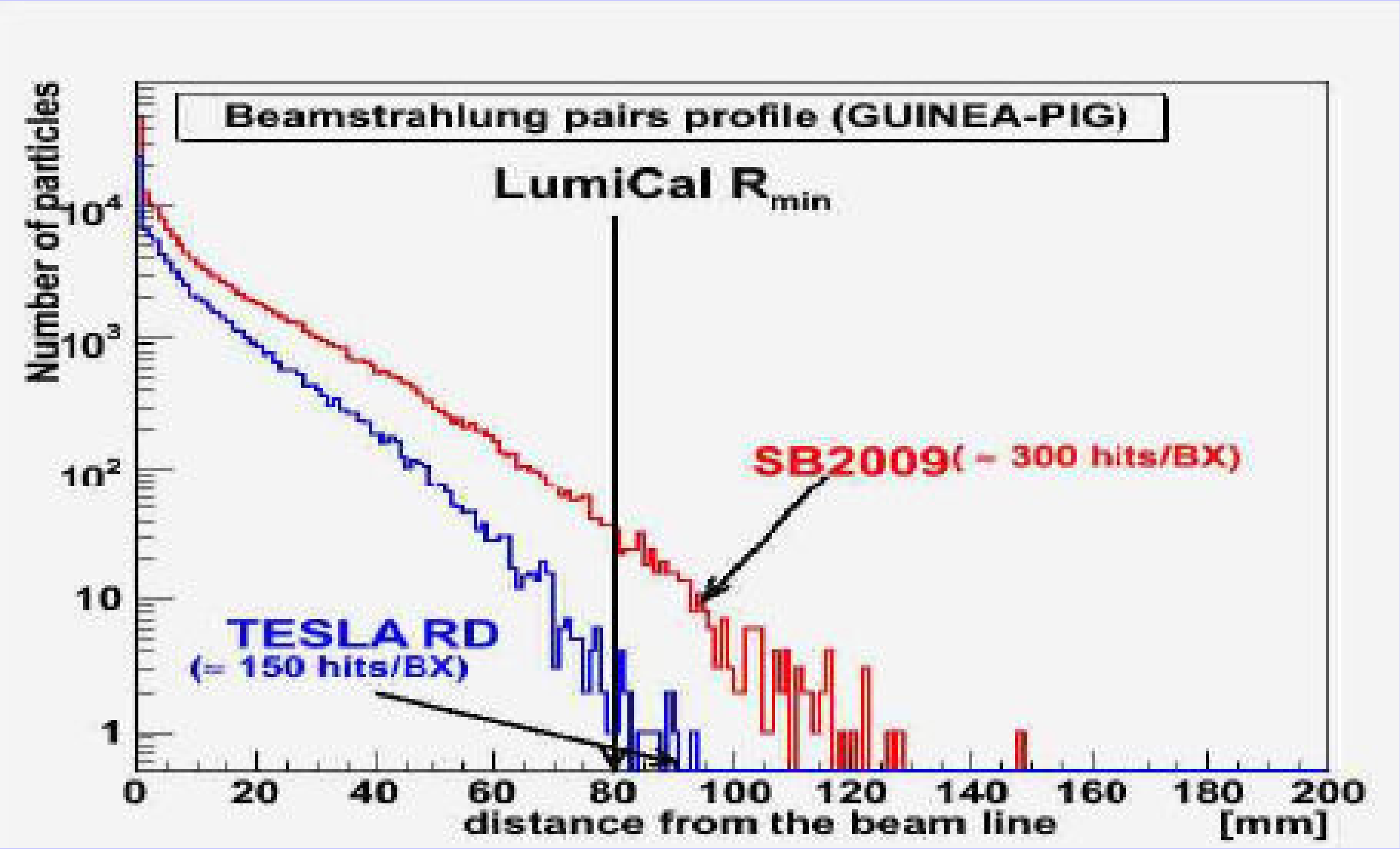
For R-Phi segmentation
Background

sHEe



50 GeV: R-Phi after 6-th ring and for square segmentation only after 5-6-th rings.
250 GeV: R-Phi – for inner rings Edep(sHEe) < 3RMS up to 3 ring, for the square segmentation only after 3-4-th rings.

Simulation Studies, impact of SB2009



Background in LumiCal is enhanced

- Higher occupation,
- more (useless) data to read out

needs to be studied!

Conclusions

- As far as the geometry of the cone is concerned, SB2009-TF $\approx$ RDR-nom, but:
  - More pairs.
  - More energy.
- However, only half as many BX:es/time $\rightarrow$ VTX, TPC sees very similar number of hits.
- Other single-BX read-out detectors have comfortably low levels. Possible exception: FTD.
- Twice as many pairs within almost the same radius in the BeamCal, and higher energies: How much will tagging suffer ?
- Full simulation of BeamCal and LumiCal with SB2009 is going on.

Take-home message:

2