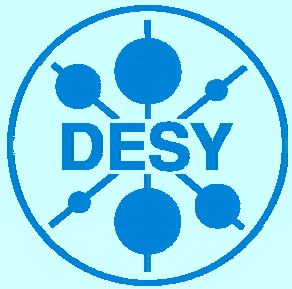
Pair Backgrounds in the Vertex Detector

Karsten Büßer



Snowmass 2005
18. August 2005

Introduction

- Backgrounds from pairs are the largest background source for the ILC detectors
- I will concentrate on the LDC detector with the CCD vertex detector option
- Different geometries under study:
  - 2 mrad crossing angle
  - 20 mrad crossing angle
- Different magnetic field configurations
  - Detector solenoid field using a realistic field map
  - Detector Integrated Dipole field with realistic field map

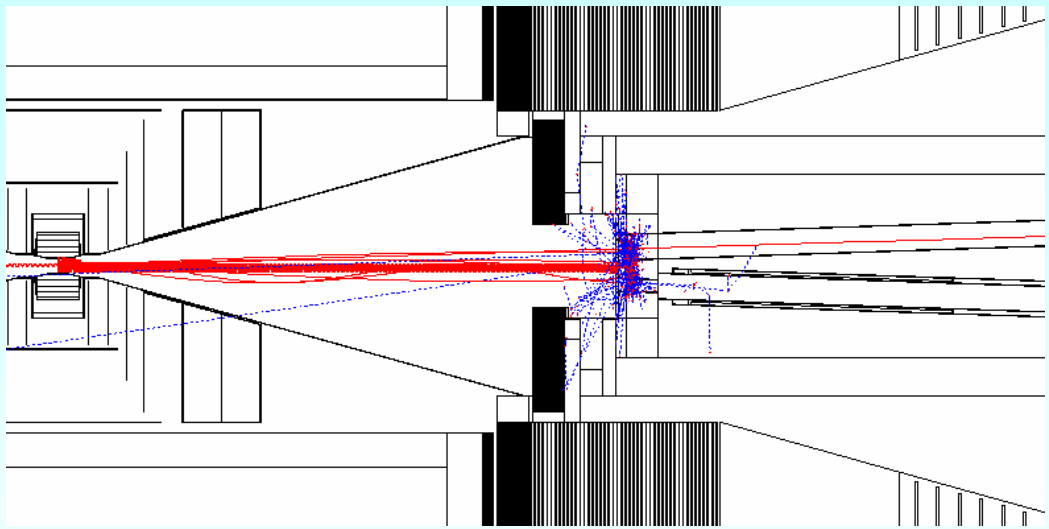
Tools

Simulations have been done using

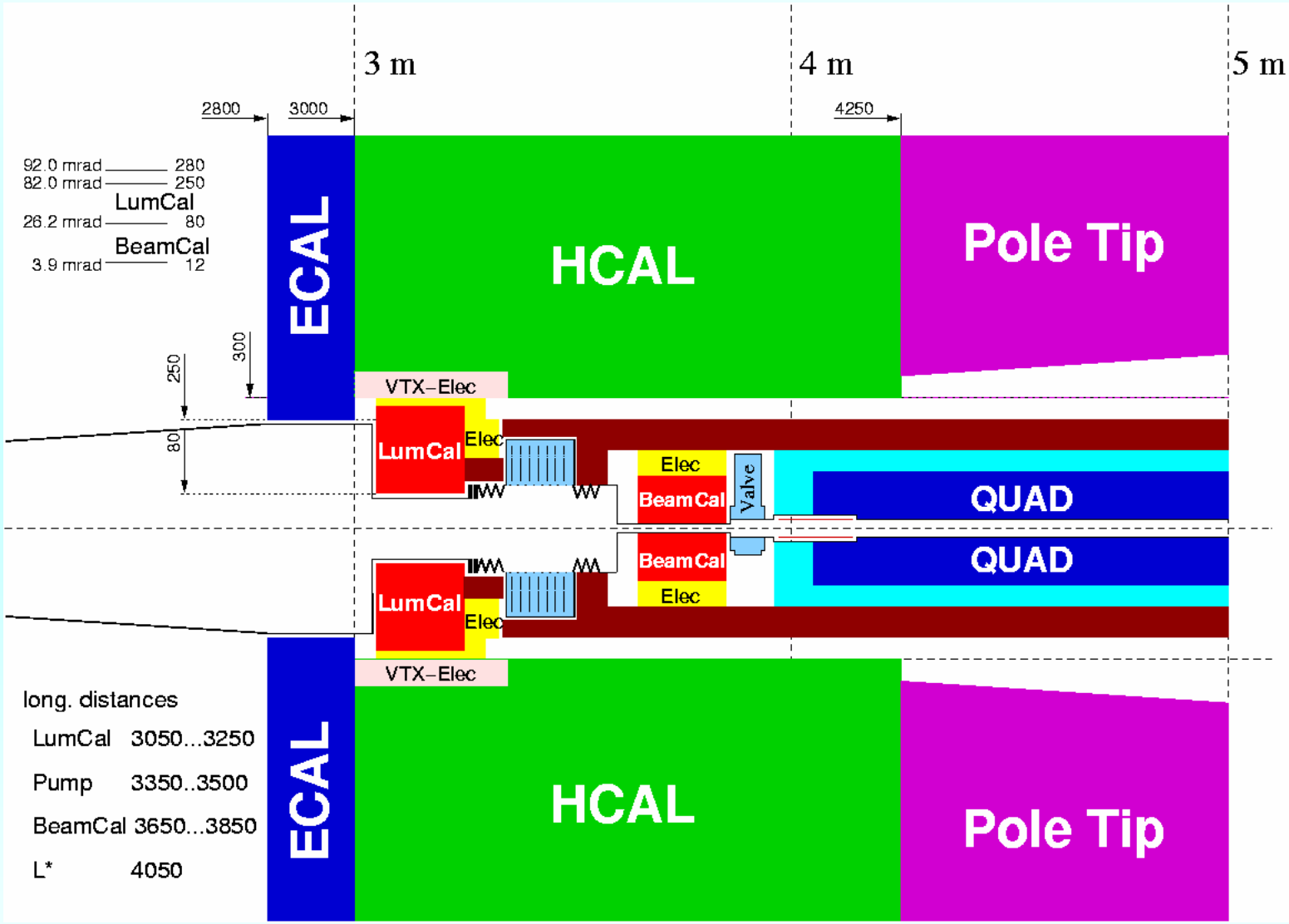
- GUINEA-PIG as generator for the pairs
- Ideal TESLA beam parameters (worse than ILC nominal)
- Full GEANT3 based TESLA detector simulation BRAHMS
- Cut-offs in GEANT3 have been lowered to 10keV for EM particles

A hit is

- every charged particle which deposes energy in a vertex detector layer

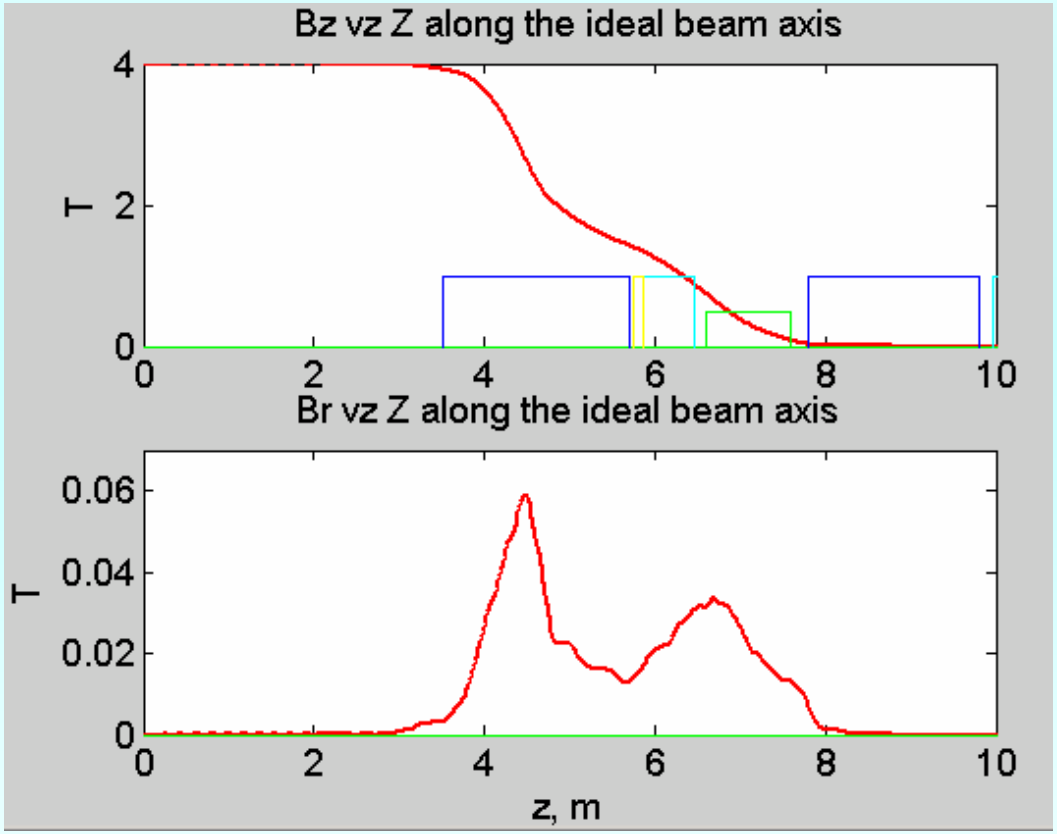


Reminder: the Forward Region Design

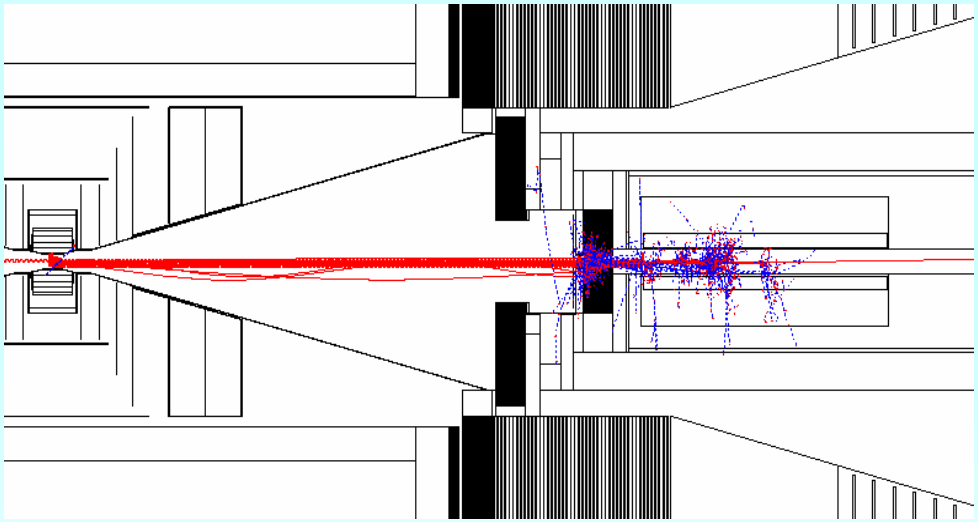


Realistic Magnetic Fields

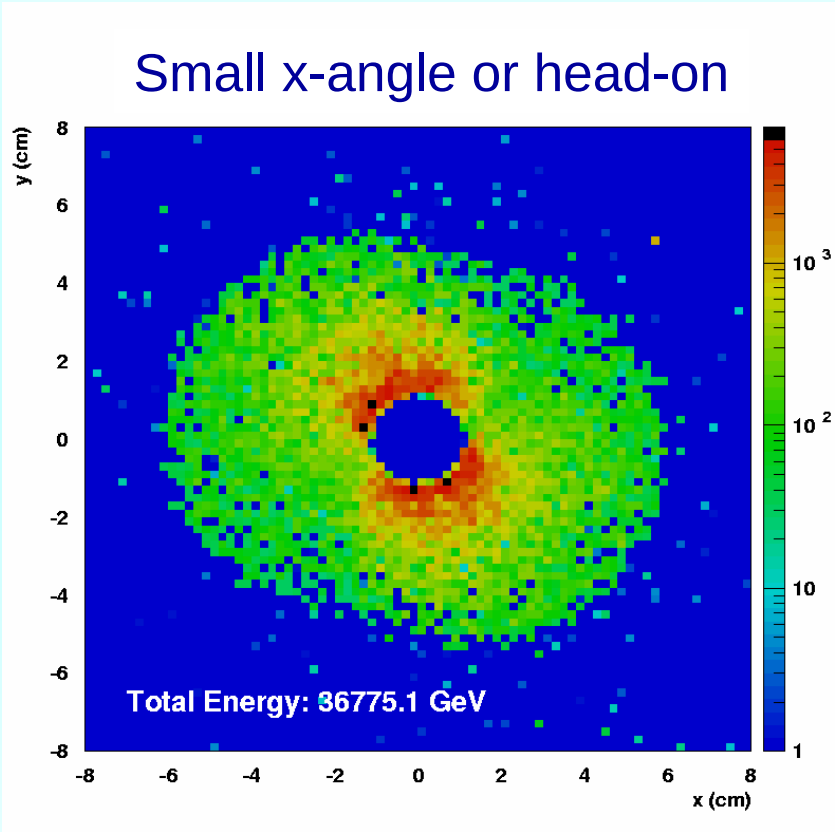
Field map for the TESLA solenoid by F. Kircher et al.



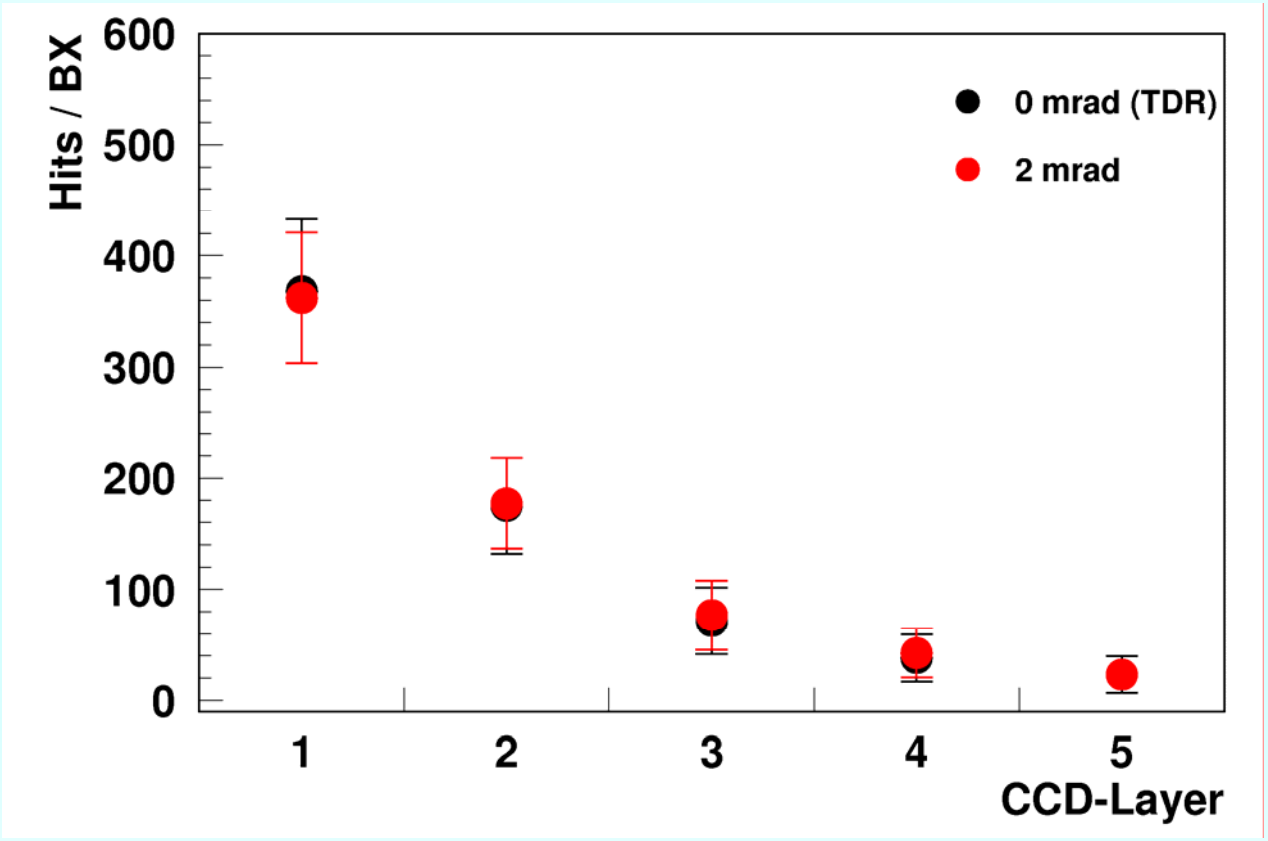
2 mrad Crossing Angle



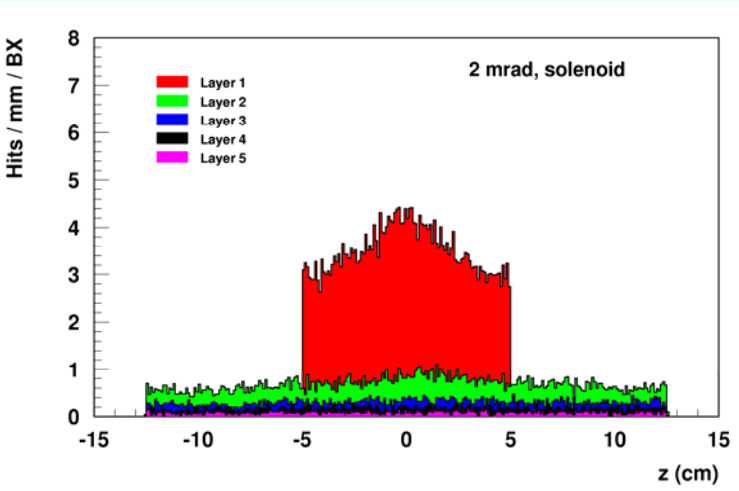
Energy deposition on the BeamCal

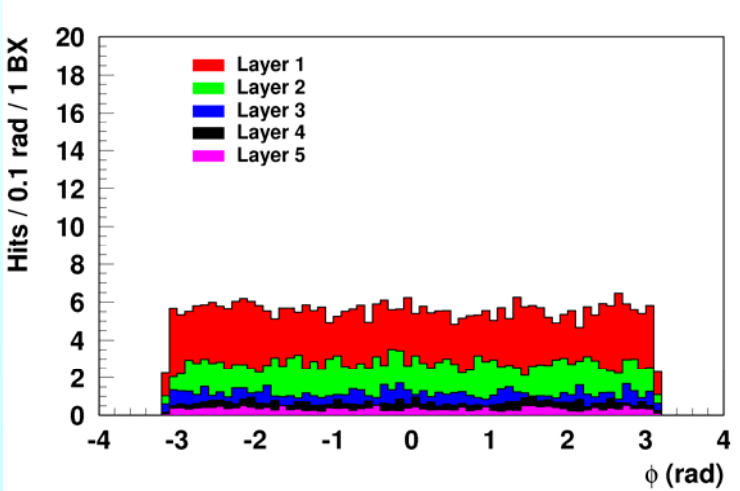


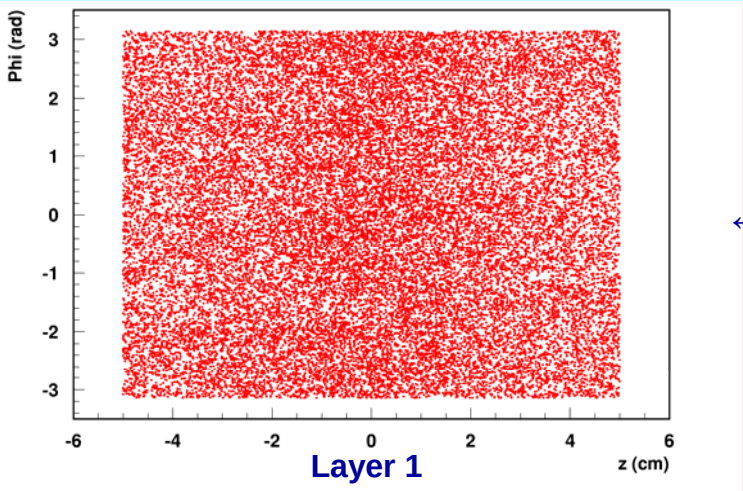
Head-on vs 2 mrad



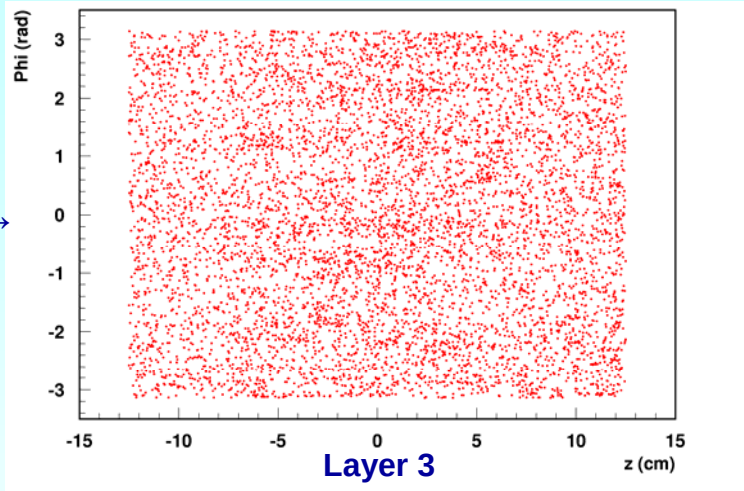
2 mrad Crossing Angle





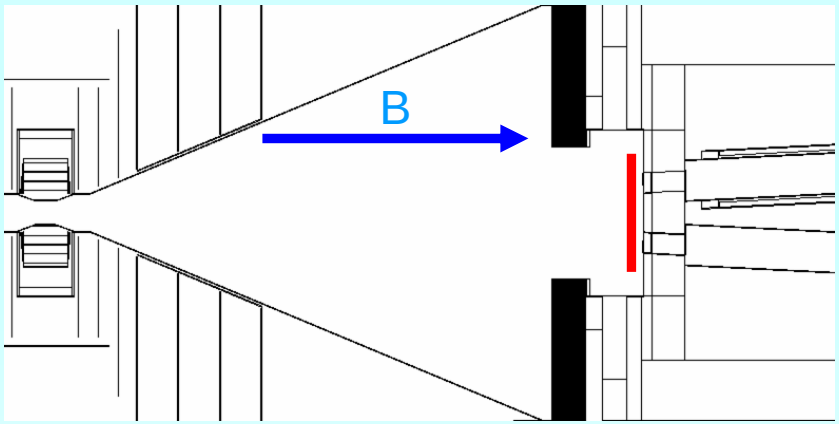


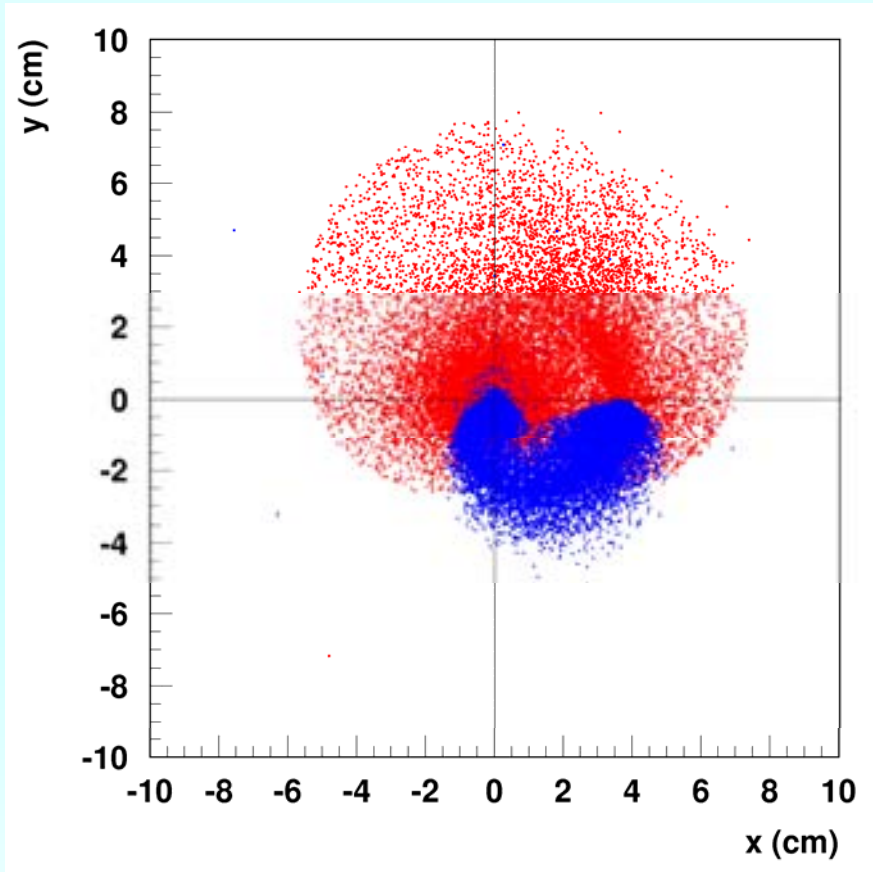
←Σ100BX→



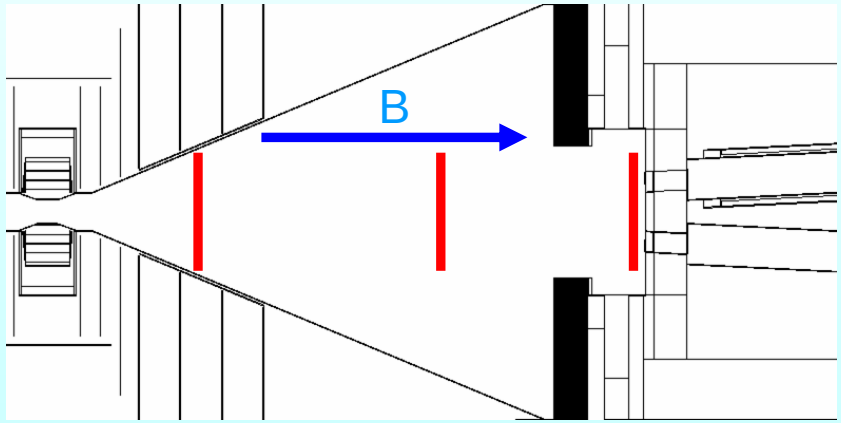
20 mrad Crossing Angle

Solenoid B-field only (realistic field map)

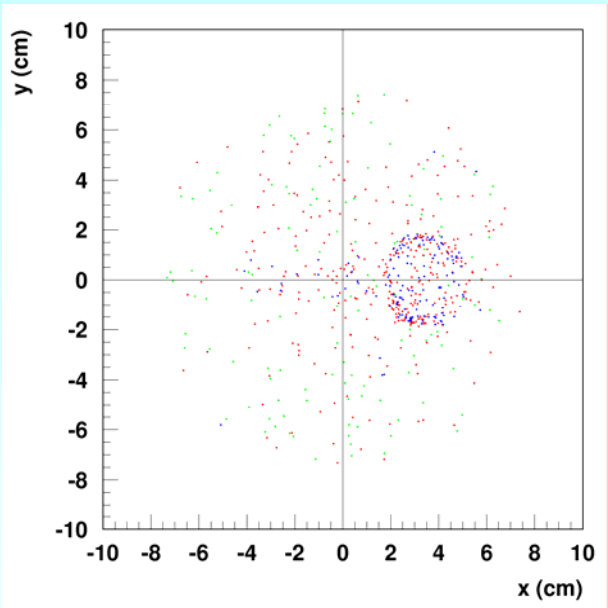


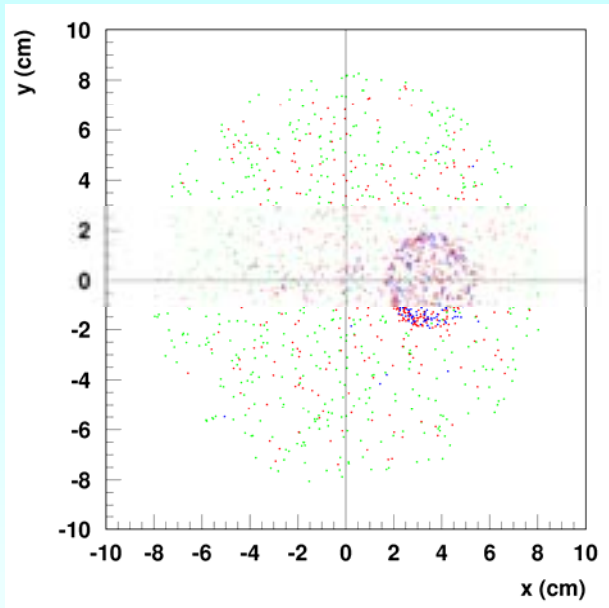


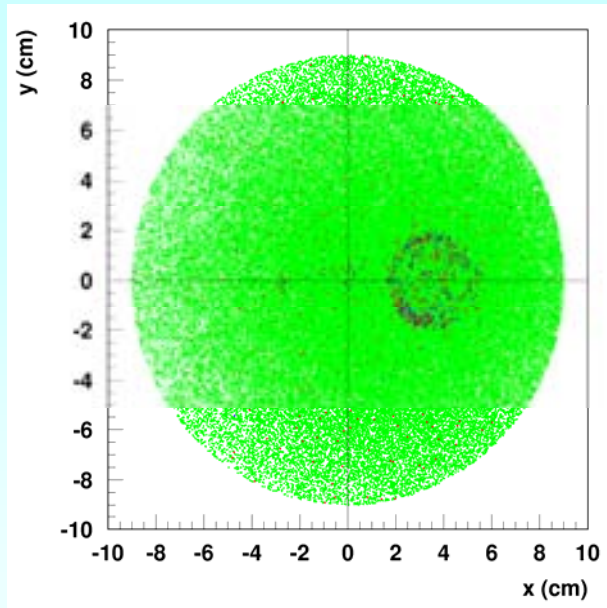
Backscattering in Solenoidal Field



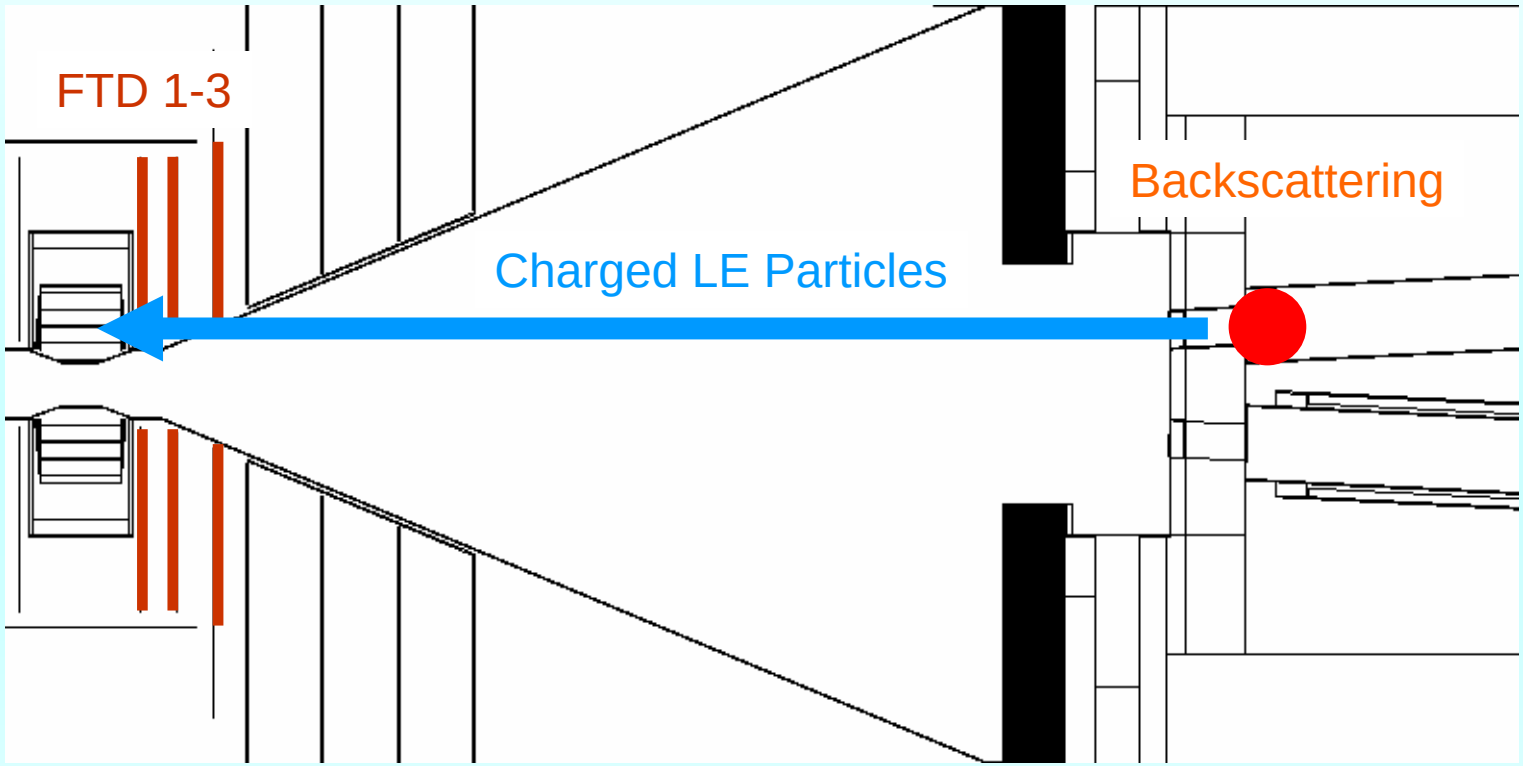
Color coding:
Photons
Electrons
Positrons





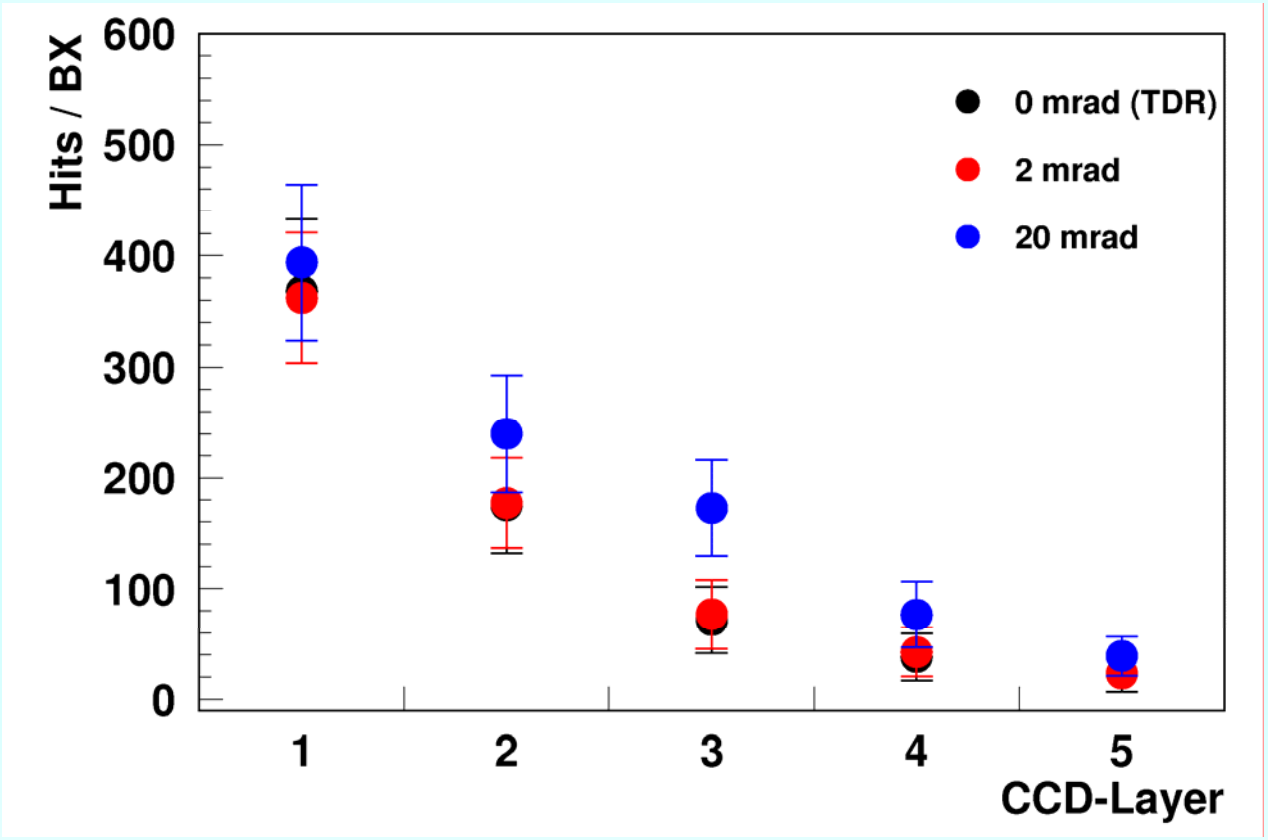


Hits on the VTX

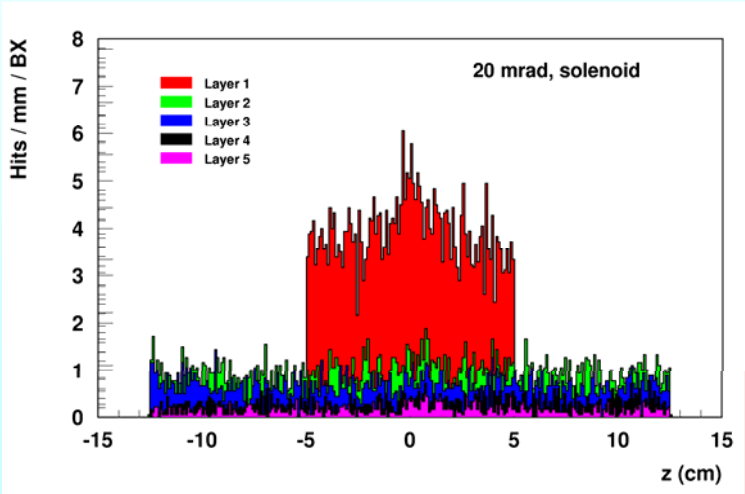


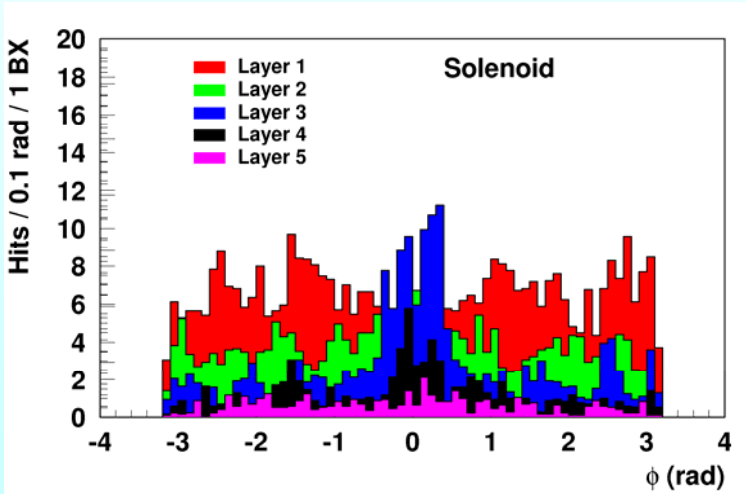
- Backscattered particles are collimated by the exit hole and aim directly to the VTX
- LE charged particles produced in the hot region are focused additionally by the solenoidal field

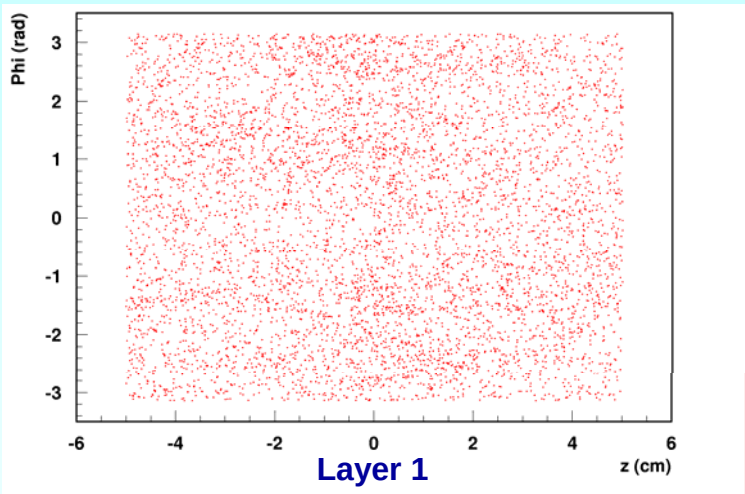
Hits on the Vertex Detector with Solenoid Field, 20 mrad



Hits on the Vertex Detector with Solenoid Field, 20 mrad







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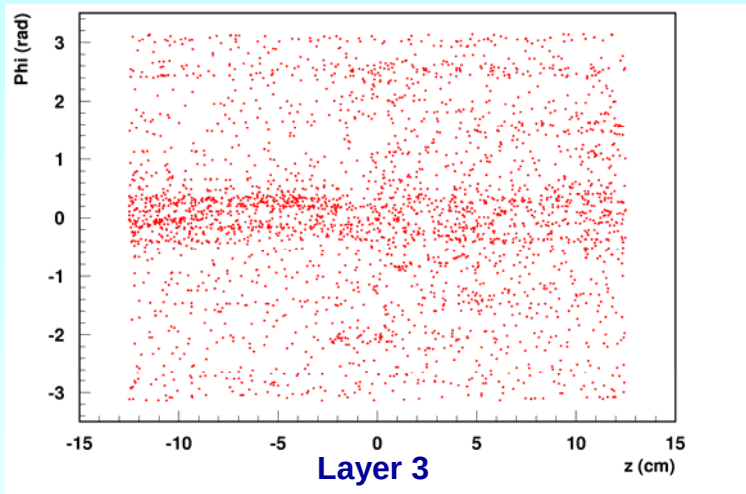
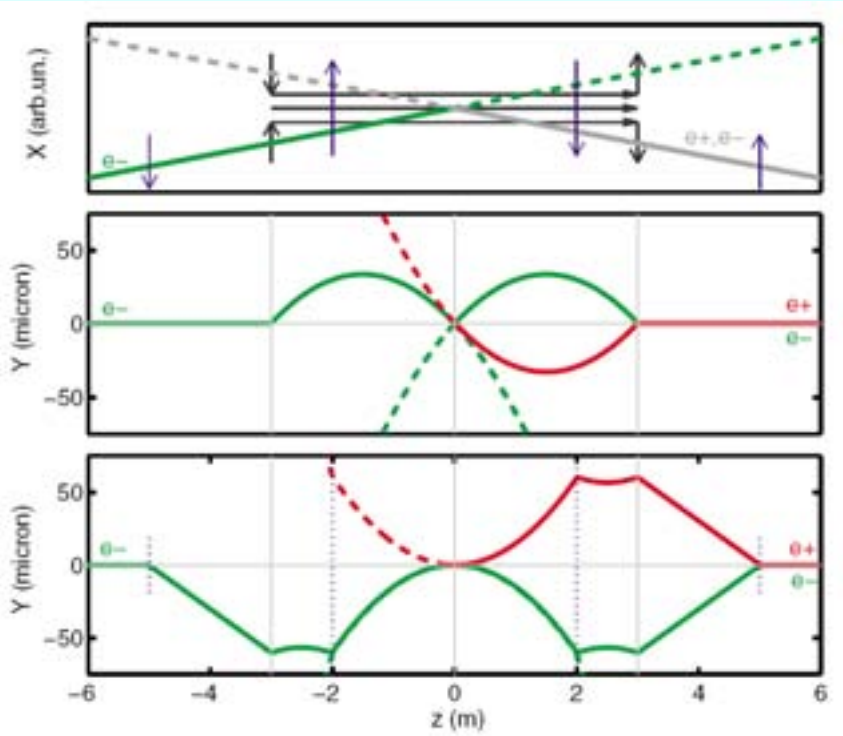


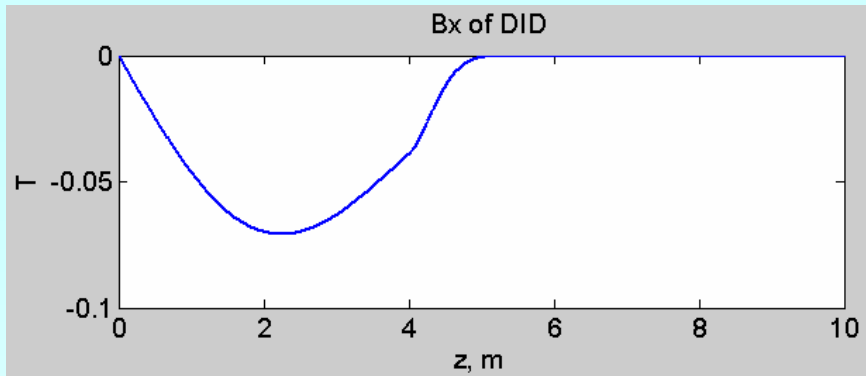
- ‘Pictures’ from the holes produce asymmetries

Detector Integrated Dipole

In a large crossing angle the beam passes the solenoid under and angle:

- Spin precesses
- Beam orbit is deflected vertically





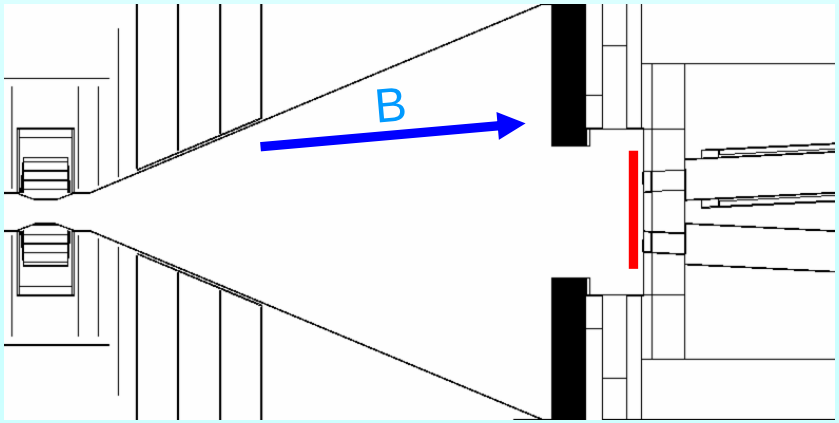
DID field by A. Seryi and B. Parker

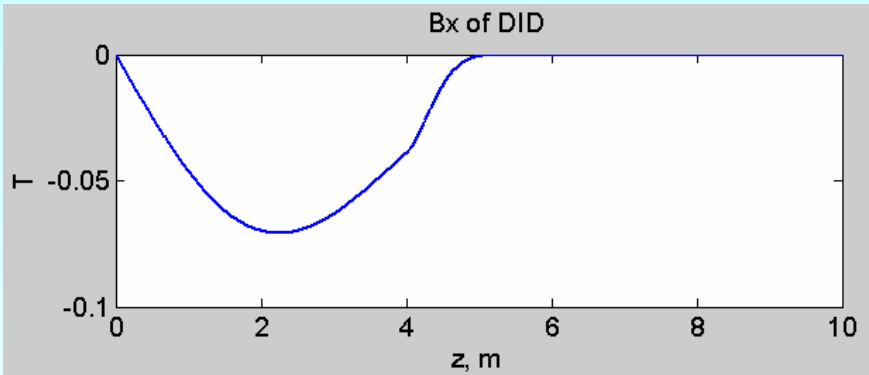
Detector Integrated Dipole field plus external correctors:

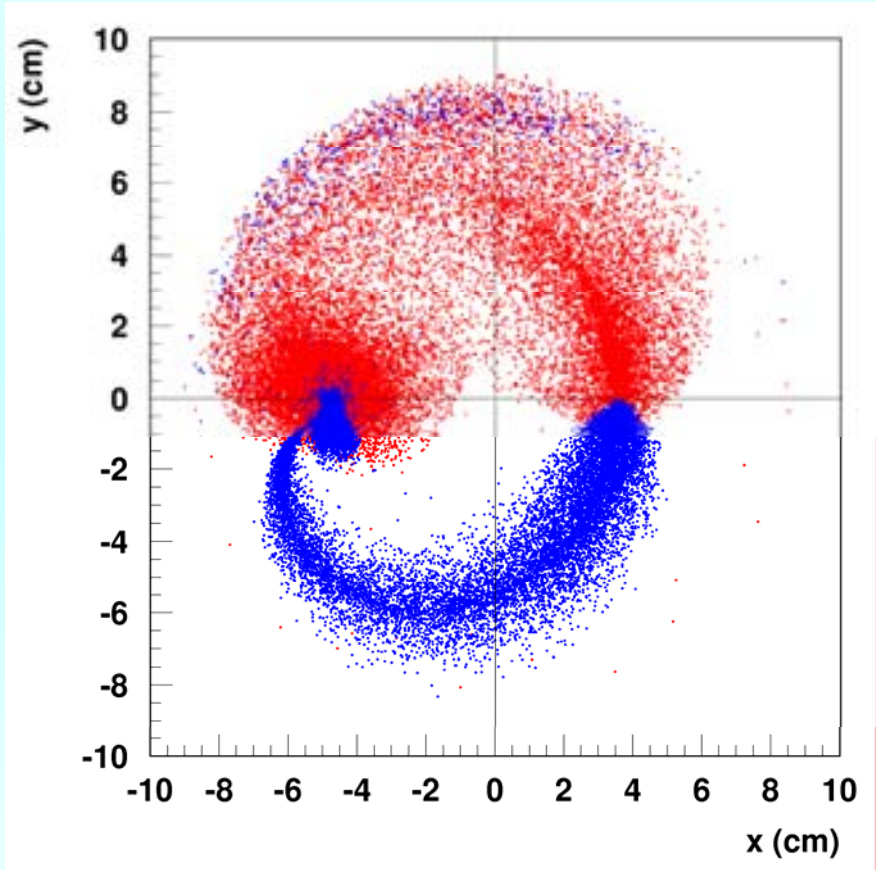
- Minimise vertical angle at IP
- Minimise beam growth due to synchrotron radiation

20 mrad Crossing Angle

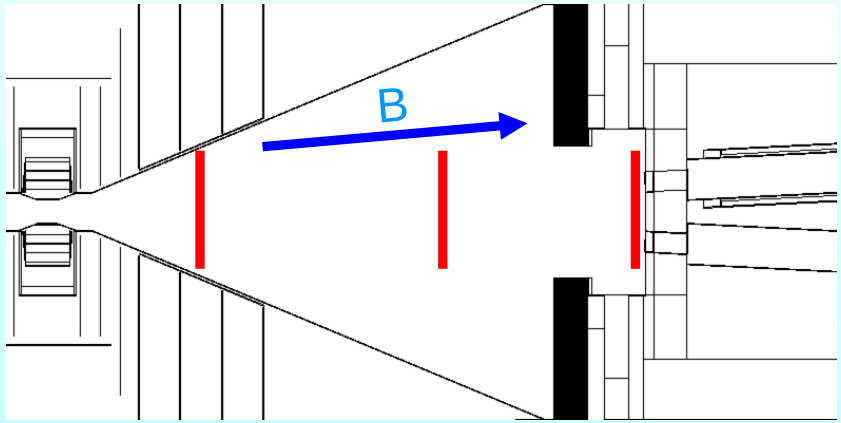
Added dipole correction field (“DID”)



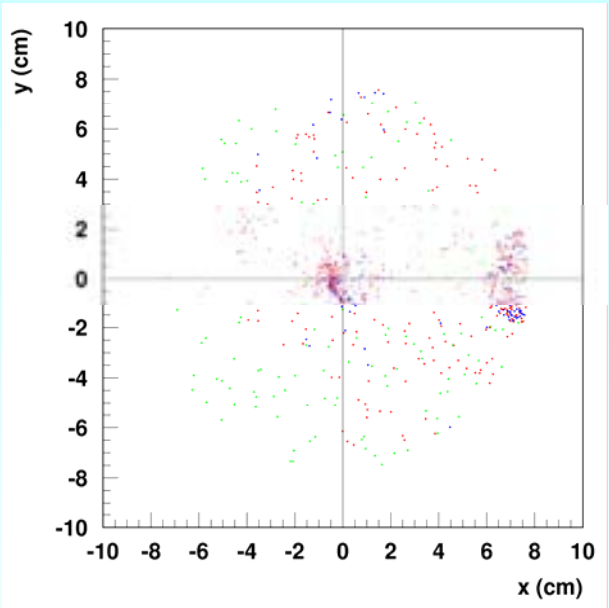


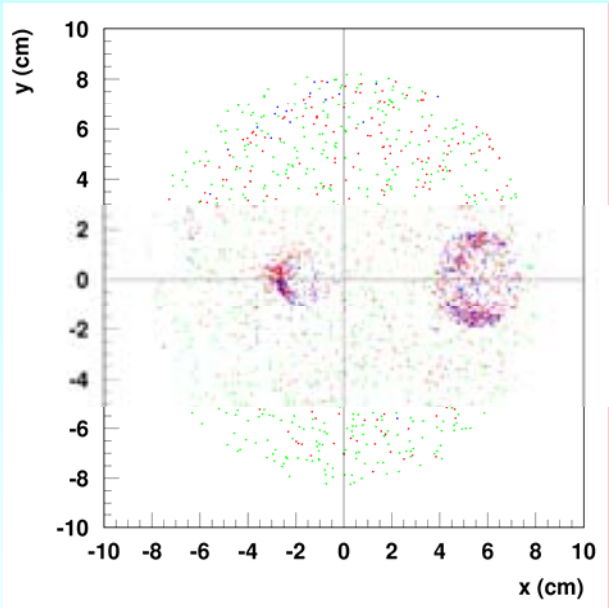


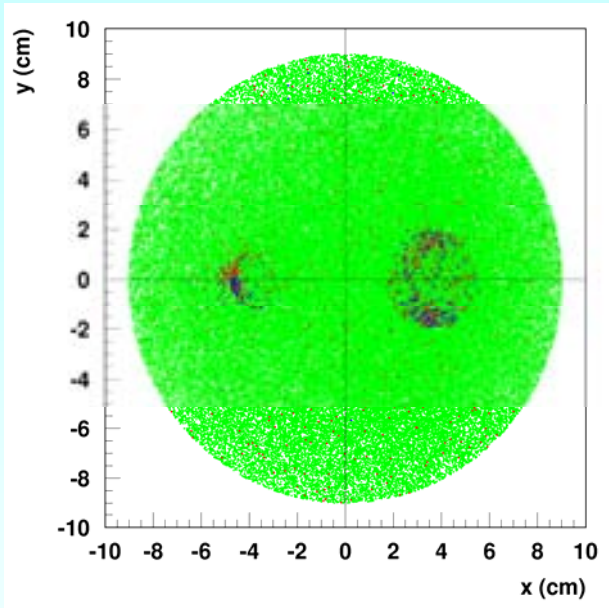
Backscattering with DID



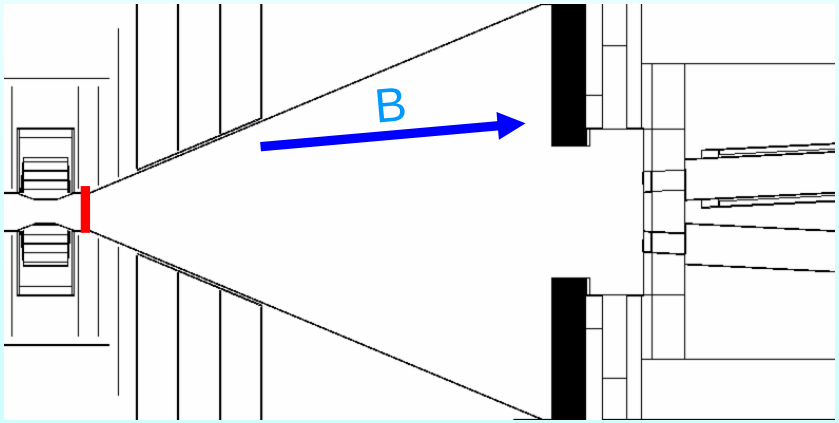
Color coding:
Photons
Electrons
Poitrons



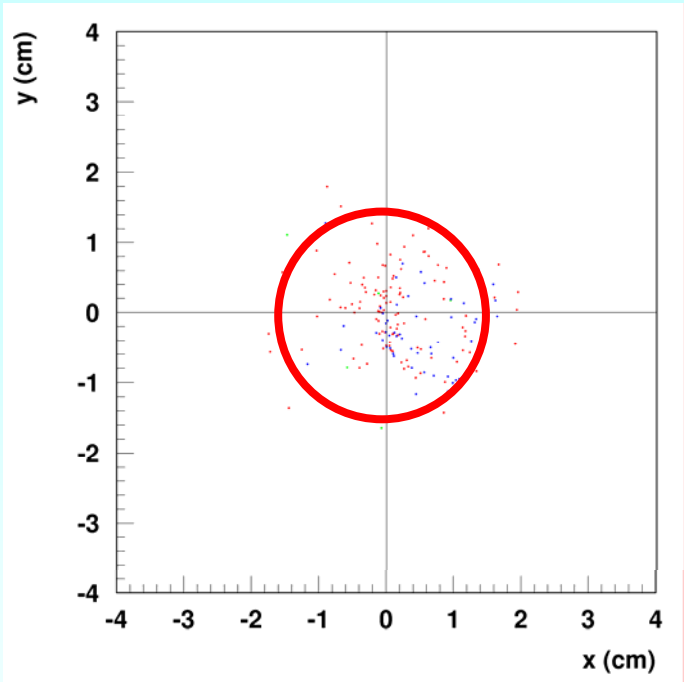




Backscattering with DID

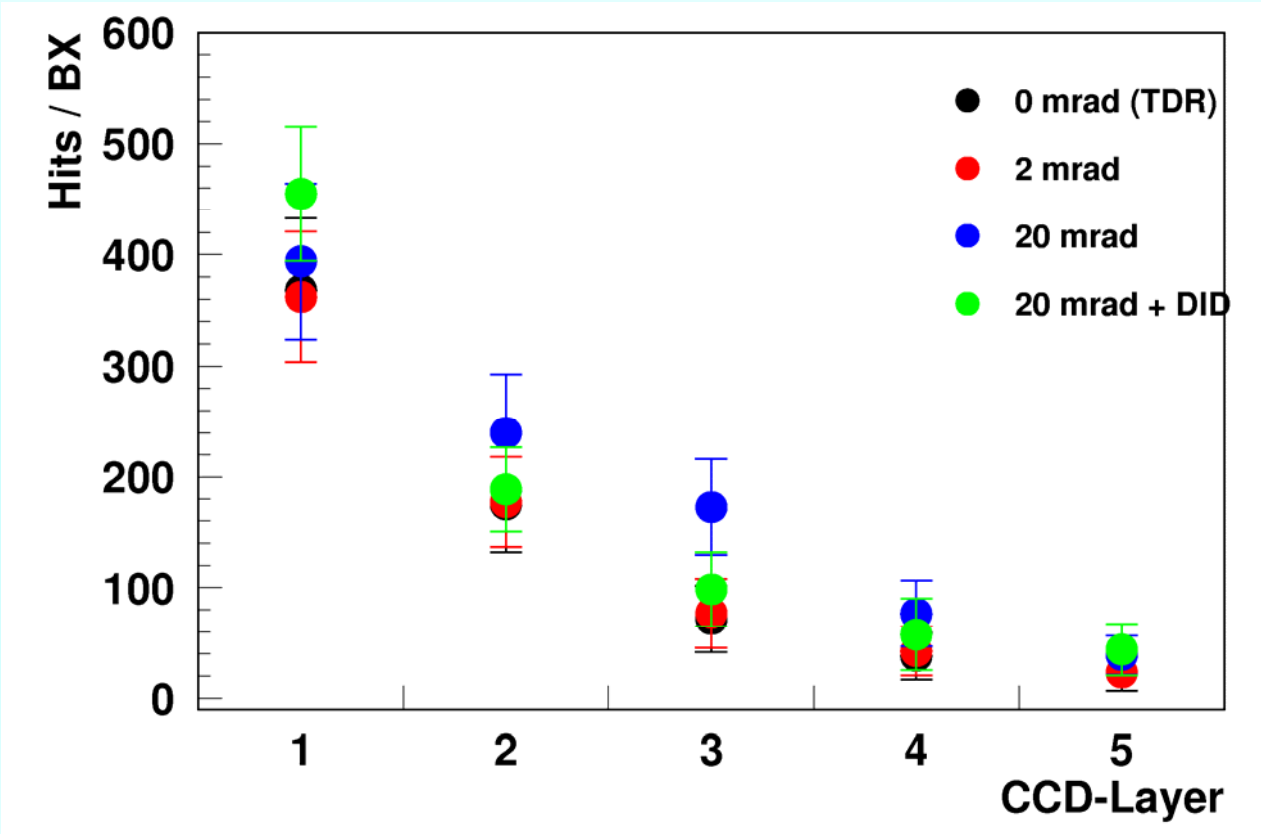


Color coding:
Photons
Electrons
Poitrons

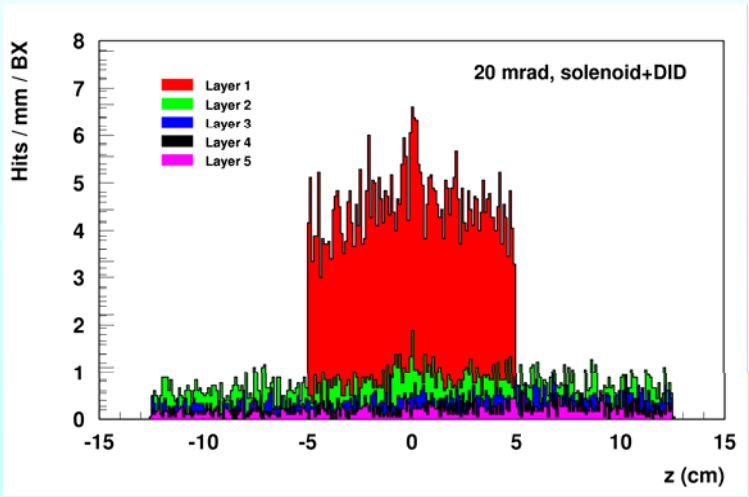


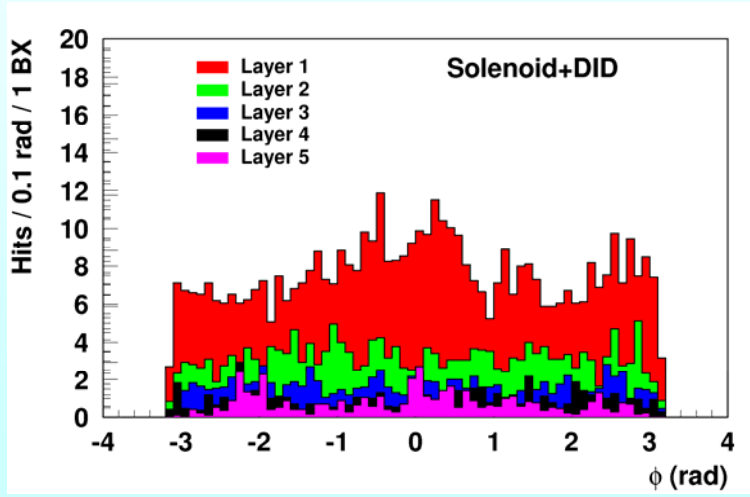
Inner VTX layer

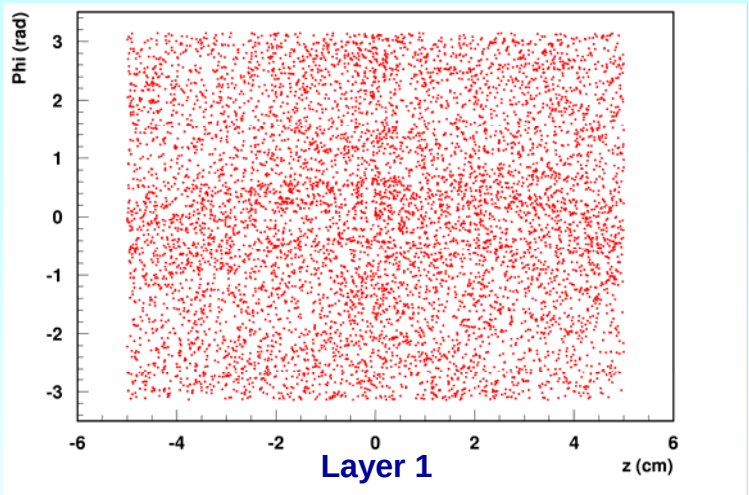
Adding the DID



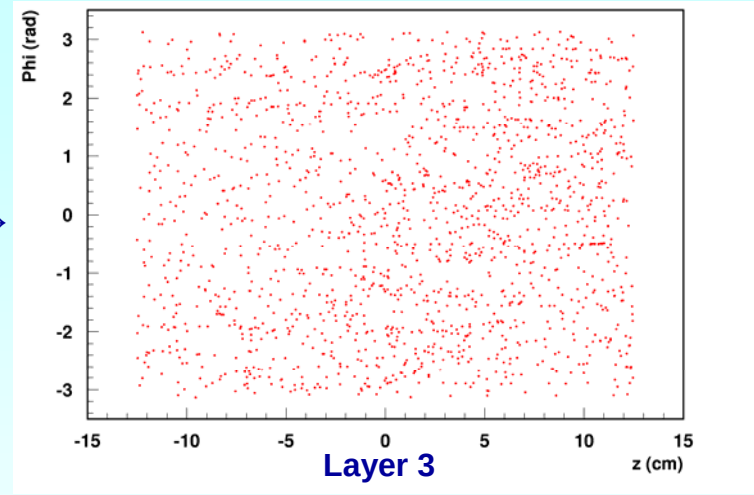
Hits on the Vertex Detector with Solenoid Field, 20 mrad





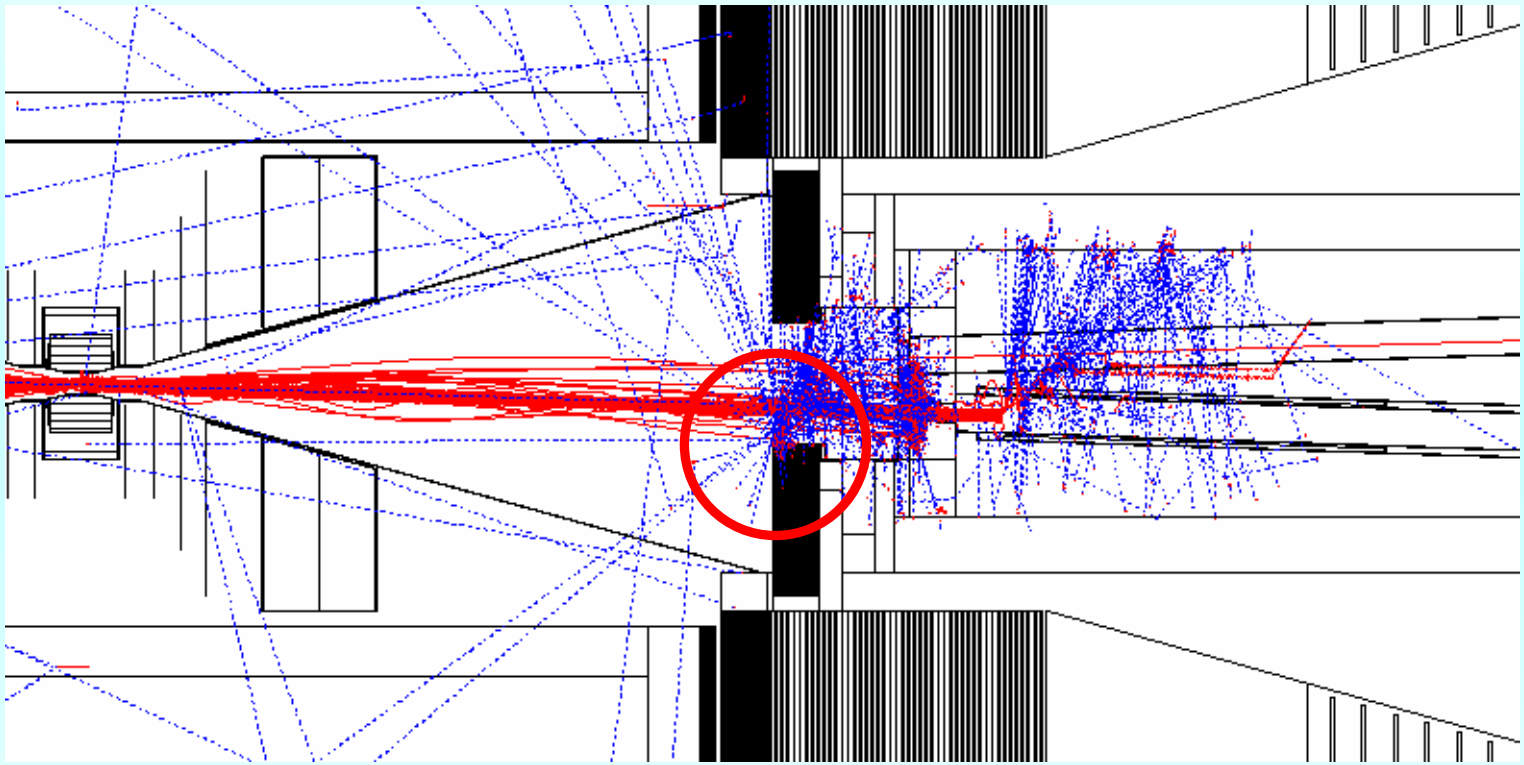


←Σ18BX→



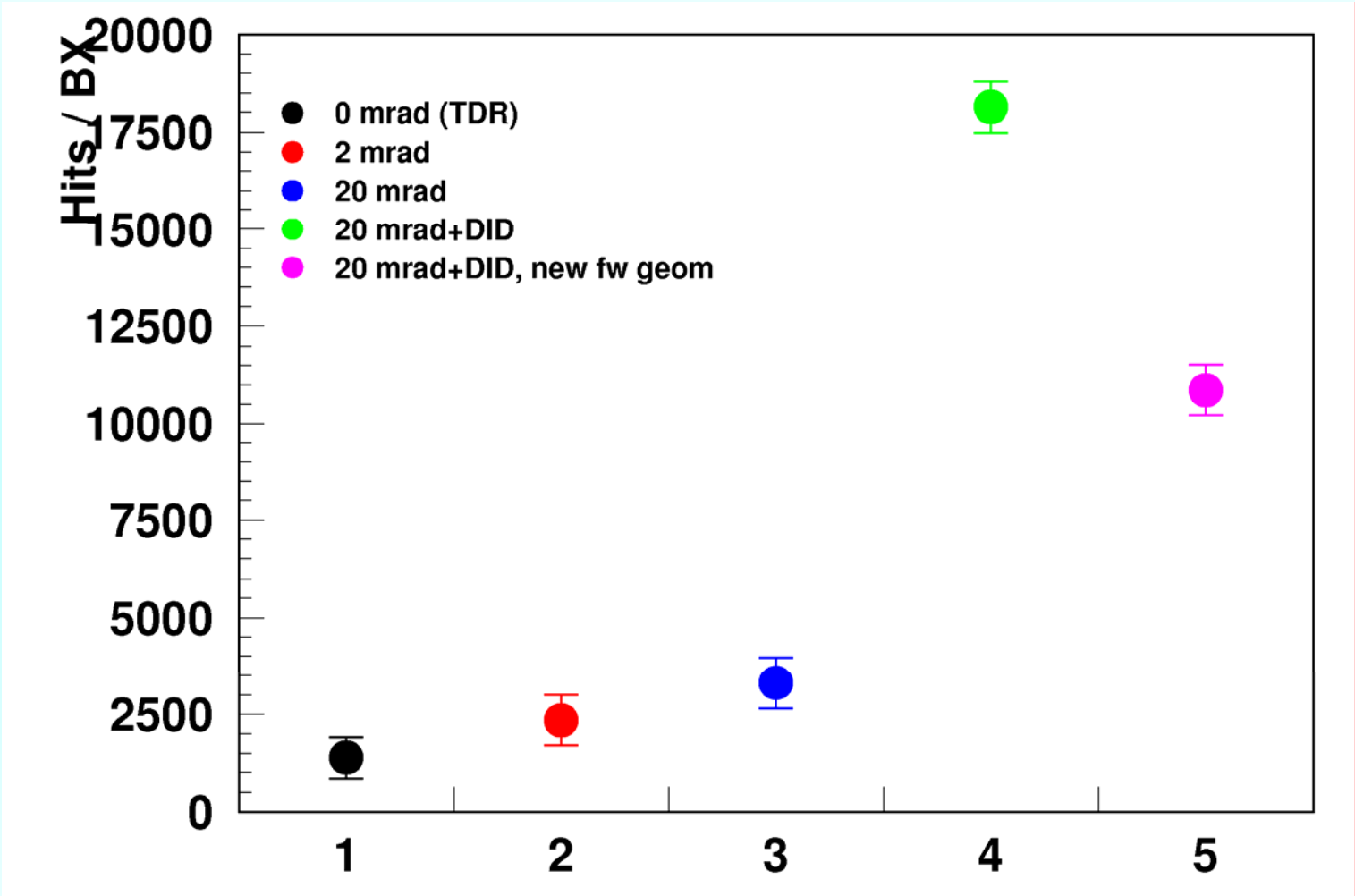
- DID removes asymmetries from outer layer but introduces (slight) asymmetry in first layer

Other Background Problem with DID



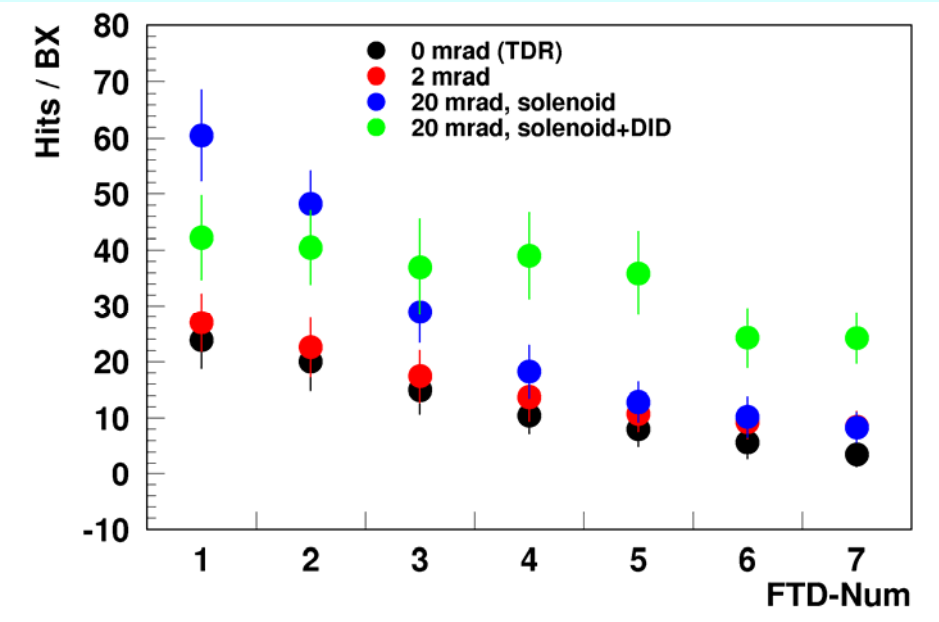
Pairs hit edge of LumiCal

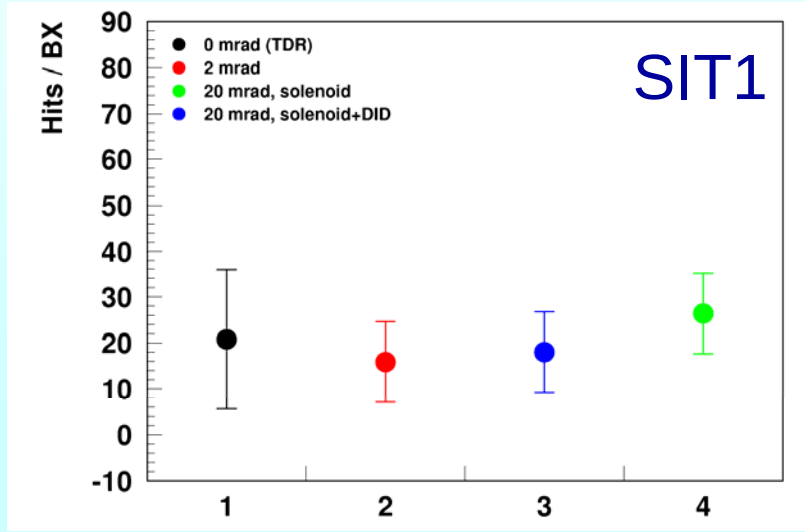
TPC Hits

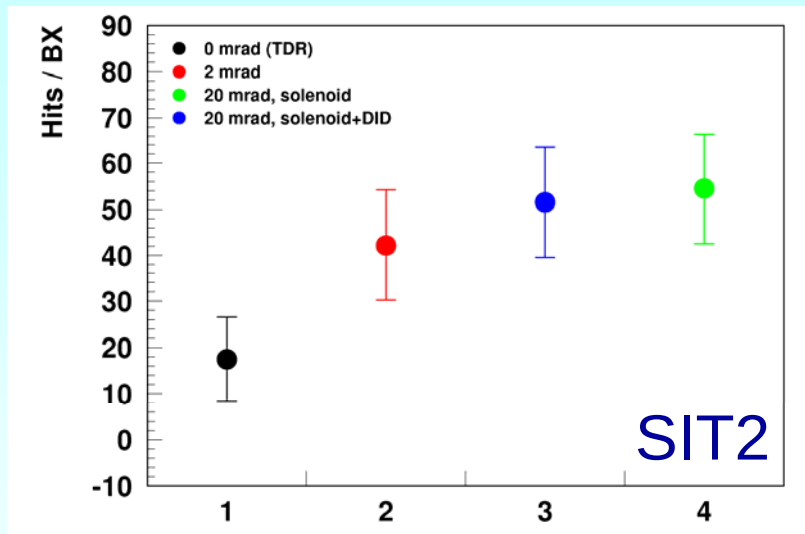

Hits / BX
20000
17500
15000
12500
10000
7500
5000
2500
0
1
2
3
4
5
0 mrad (TDR)
2 mrad
20 mrad
20 mrad+DID
20 mrad+DID, new fw geom

Other Tracking Devices

Forward Tracking Disks







Conclusion

- current DID fields (with the current detector design)
  - guides low energetic charged particles coming from the hole for the incoming beam into the first layer of the vertex detector
    - The effect is small here, but this is potentially dangerous for the vertex detector

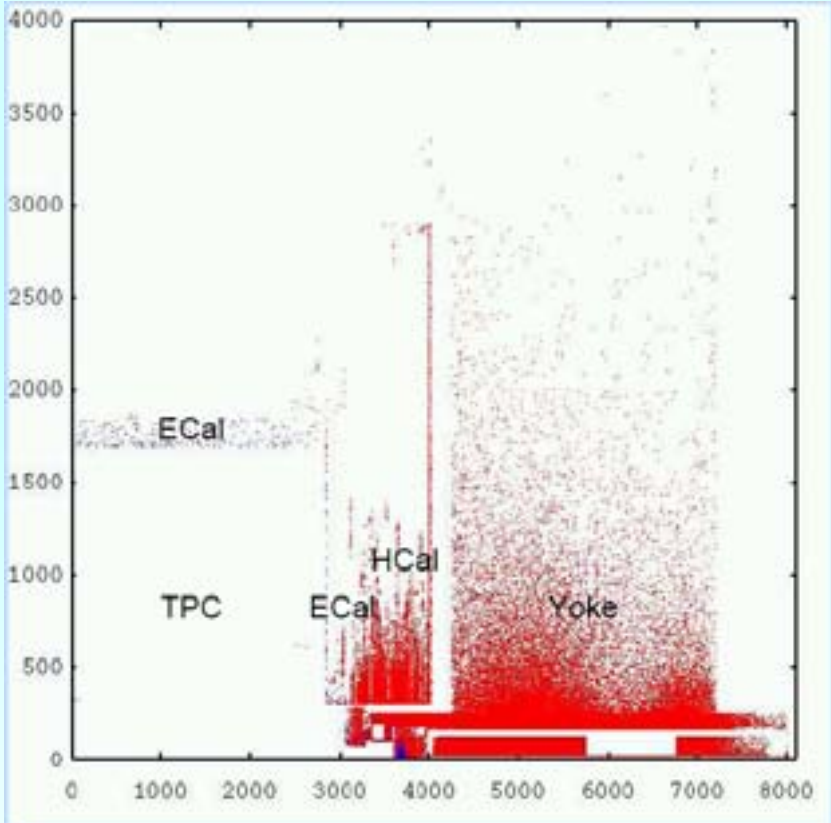
    → Every low energetic charged particle coming from upstream is guided into the inner VTX layer
  - increase backgrounds in the TPC (and the forward chambers) significantly

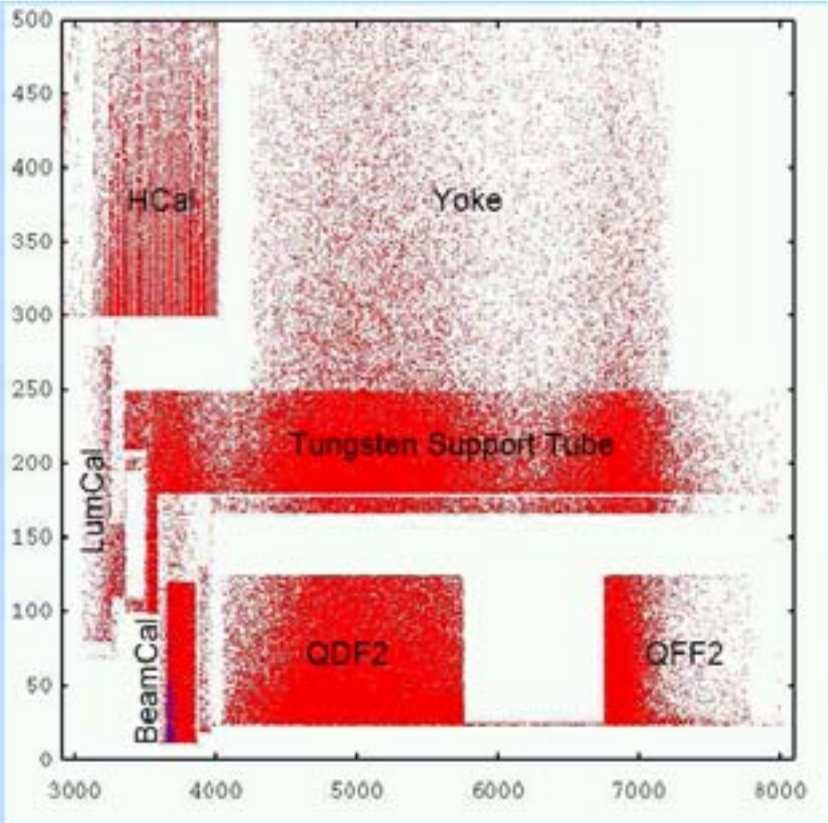
    → a quick fix to the geometries of the forward region brings no substantial improvement to the TPC backgrounds
- To be done
  - invent a solution for the vertex detector backgrounds (tune DID field?)
  - invent a clever solution to heal the TPC background problem
  - understand detector tolerances
- Be careful:
  - Magnetic field configurations can have big impact on backgrounds!

Outlook

Switch to MOKKA (Geant4):

- cross-check results
- study the neutrons





First results (A. Vogel)