The Large Detector
with Realistic Magnetic Fields

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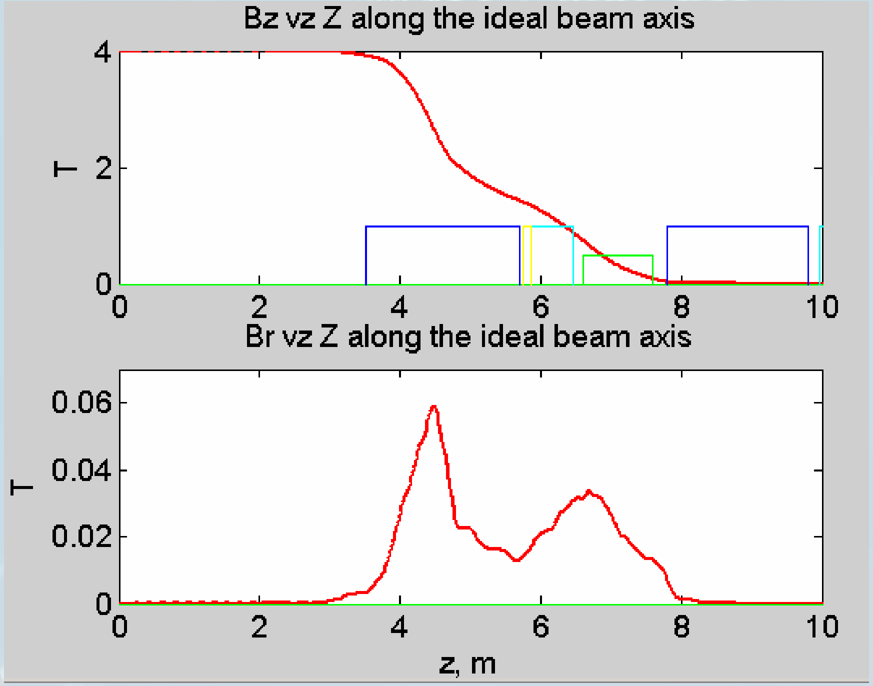
The Magnetic Field Configuration

- Tracking needs uniform solenoid field, B=4T
- Lots of work went into the design of the detector solenoid coil at the time of the TESLA TDR:



- TPC extends to z=2.5 m
  - → Good assumption so far: uniform B-field with 4T
  - → implemented as such in BRAHMS, MOKKA, etc.

New Requirements

- Large crossing angle (~20 mrad):
  - Beams pass through the detector solenoid under a crossing angle:
    - vertical orbit displacement
      $\rightarrow$ degradation of beam size due to synchrotron radiation
    - spin precession
      $\rightarrow$ precision on polarisation measurement
  - Local correction field is needed
  - Proposal by A. Seryi and B. Parker:

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Compensation of the effects of a detector solenoid on the vertical beam orbit in a linear collider

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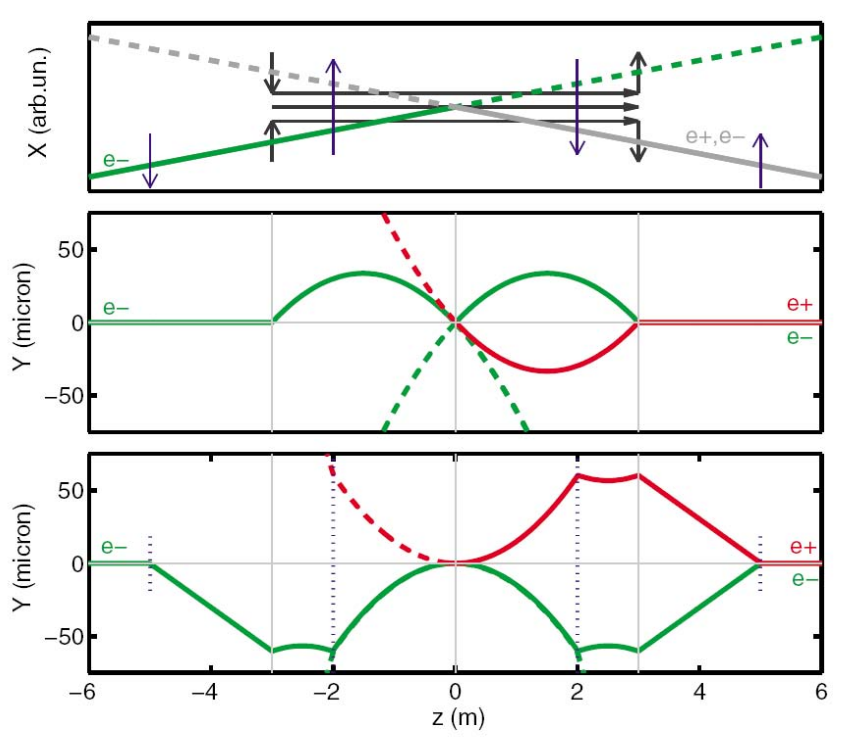
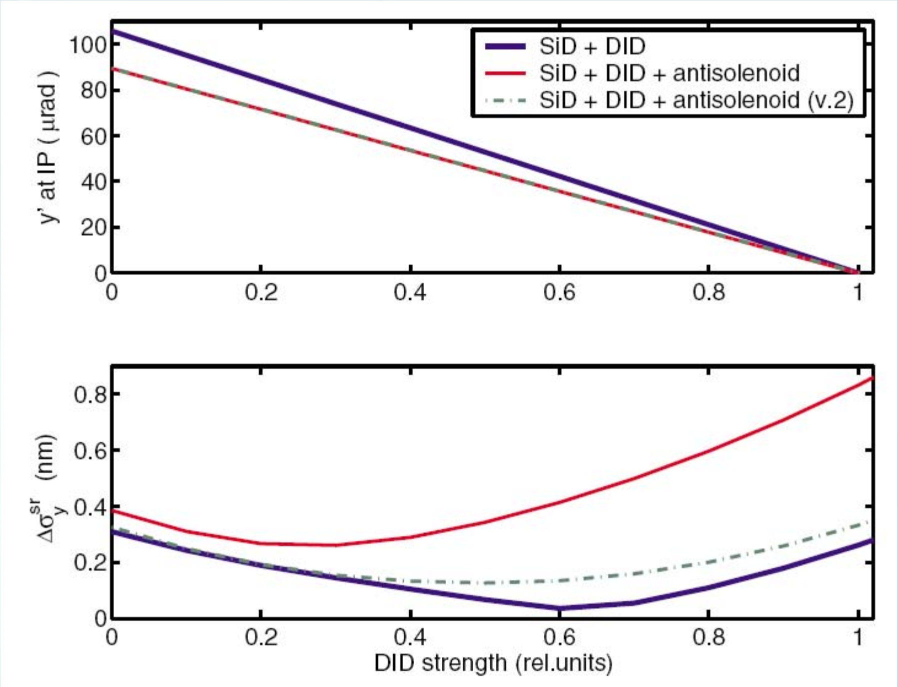
How local compensation works



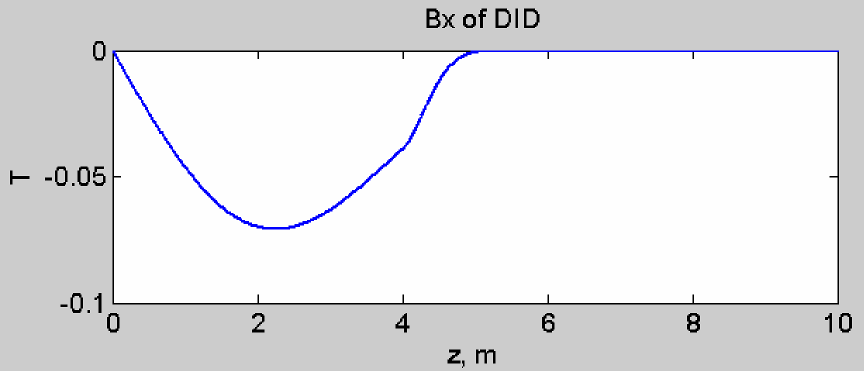


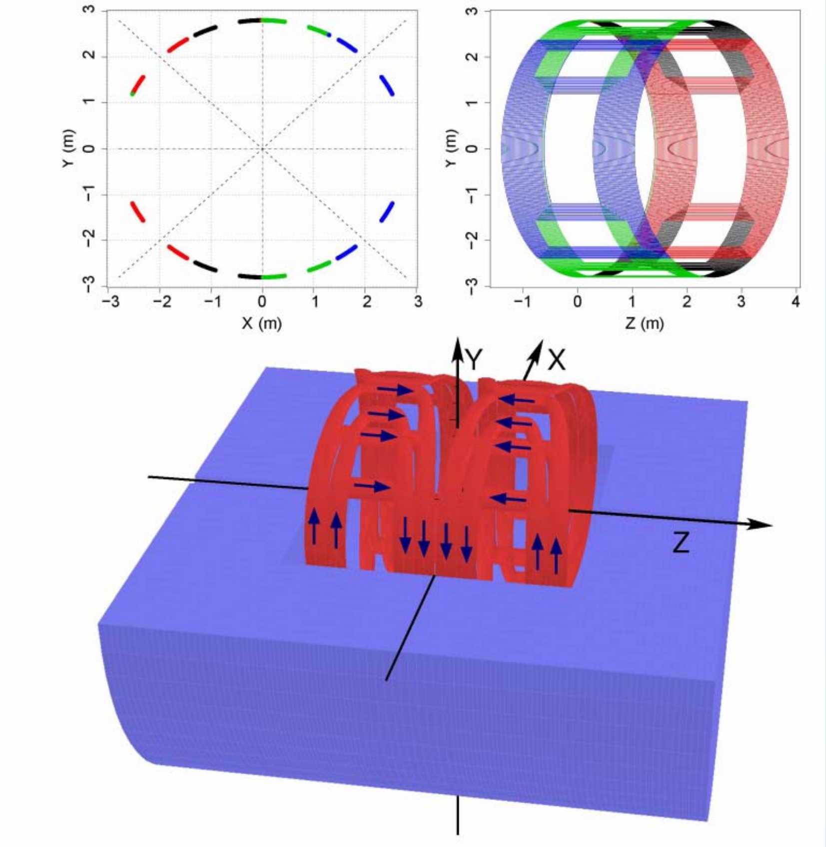
Detector Integrated Dipole field plus external correctors:

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

DID for LDC

Detector Integrated Dipole



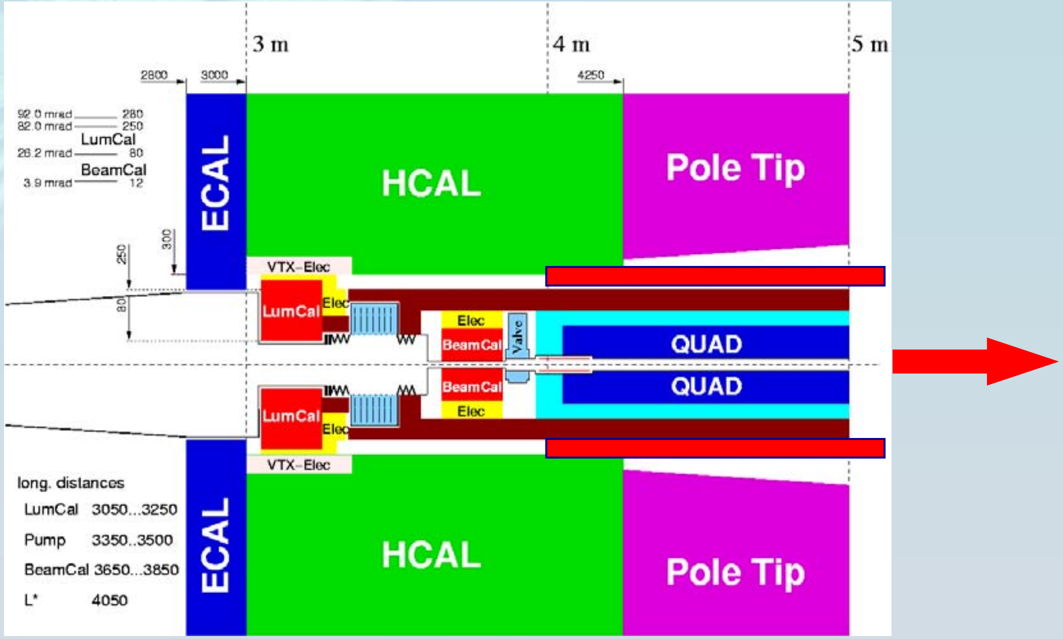


DiD field optimised for LDC solenoid
(thanks to A. Seryi and B. Parker)

Solenoid Compensation

- Solenoid field induces cross couplings and causes beam size increase
- Correction foreseen at TESLA uses skew quadrupoles
- New proposal (A. Seryi and Y. Nosochkov): use weak antisolenoids around the quadrupoles → works better at all energies

- Mechanical problem:
- Weak antisolenoids (~1.7T) are in the fringe field of the main solenoid (4T)
- 15 tons of force have to be supported



Questions

- While the local compensation schemes are attractive from the optics point of view, two LDC related questions arise:
  - What about mechanical problems (for antisolenoids)?
  - Will these magnetic fields harm the tracking abilities?
  - What happens with the pair backgrounds?

    → rest of this talk

Simulation of Pair Backgrounds

Simulations have been done using

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

A hit is

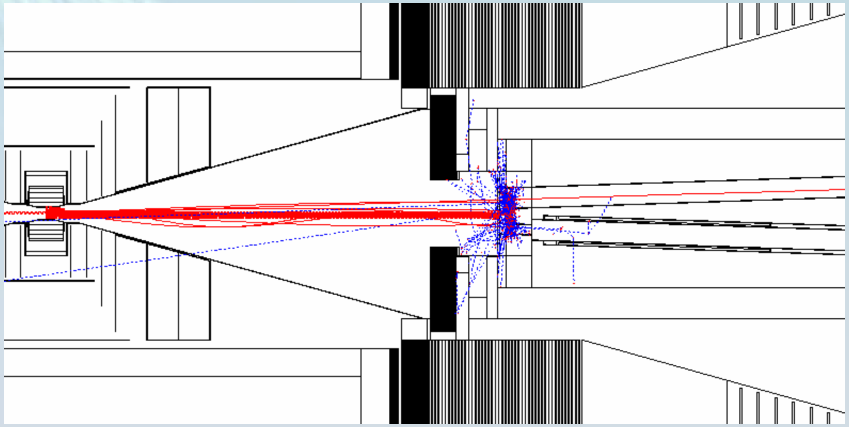
- every charged particle which deposes energy in a SI device
- every 3d hit in the TPC

Basic geometry used

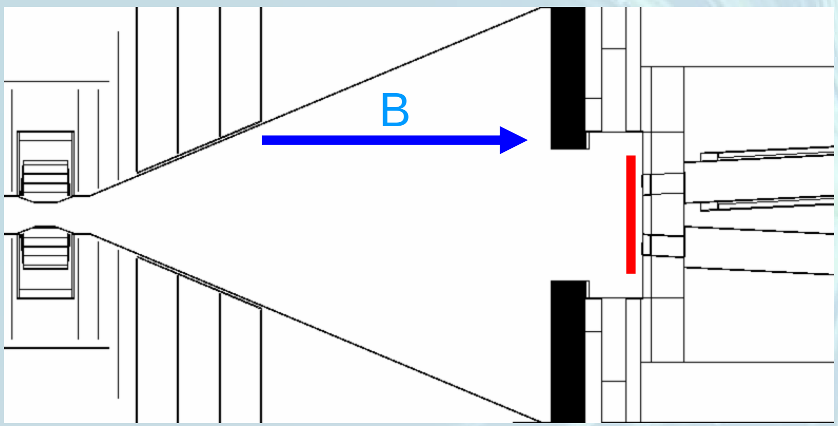
- 2*10 mrad crossing angle
- 2*1 mrad crossing angle

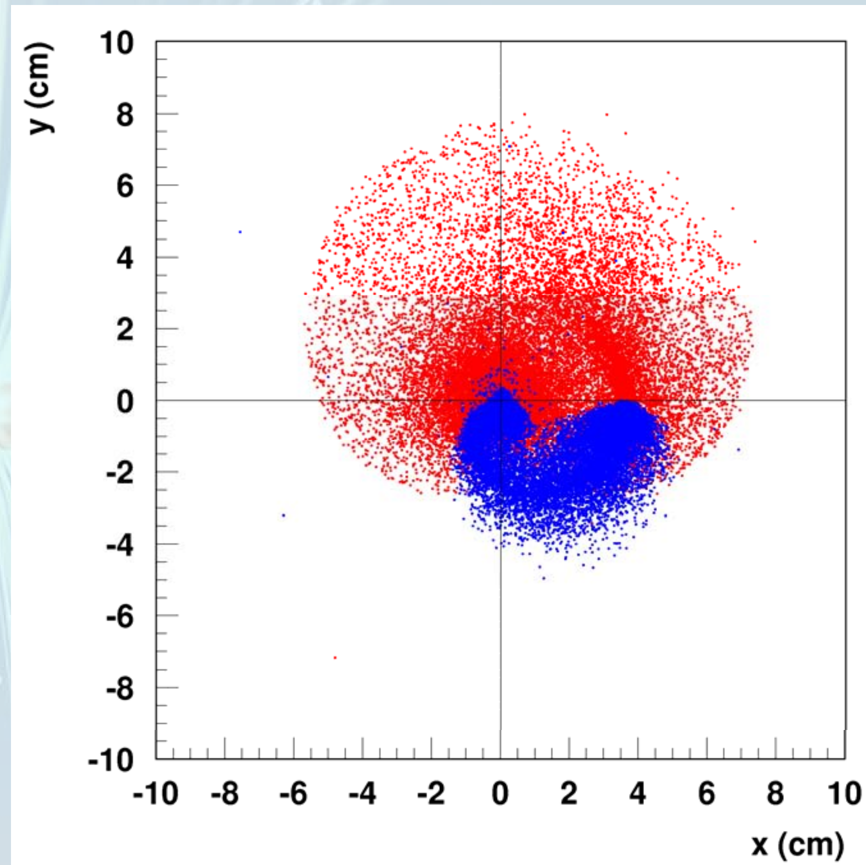
Modifications

- solenoid field map
- DID field map (for 20 mrad only)

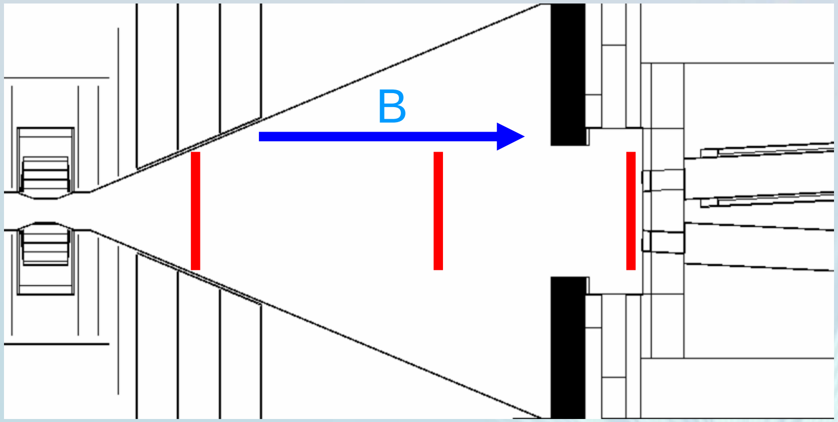


Solenoid B-field only (realistic field map)

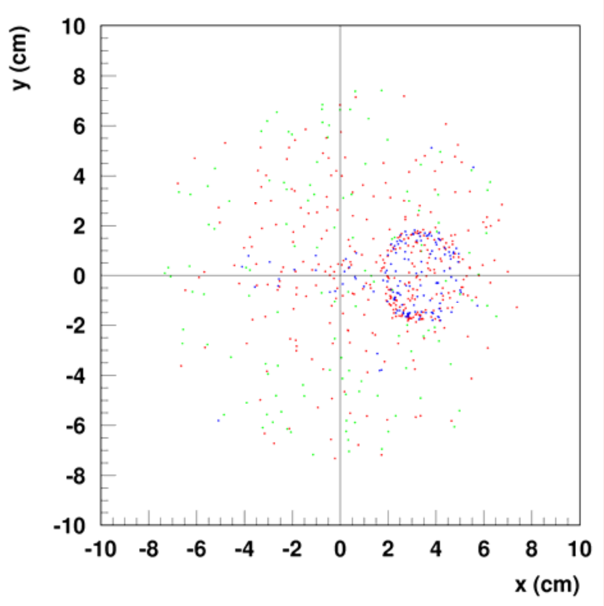


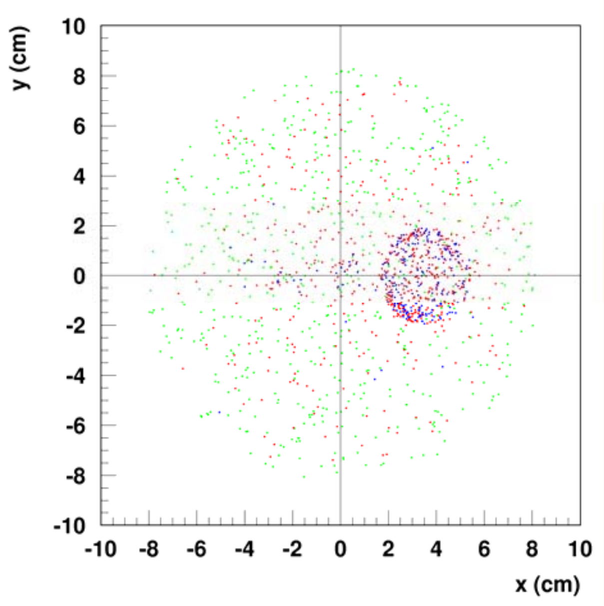


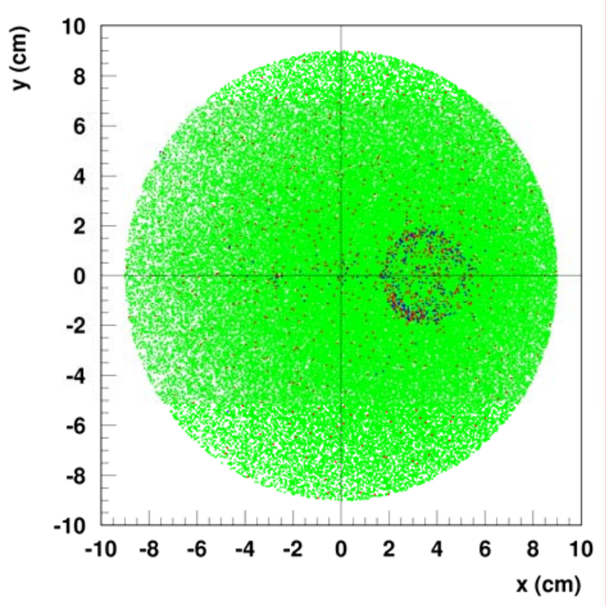
Backscattering in Solenoidal Field



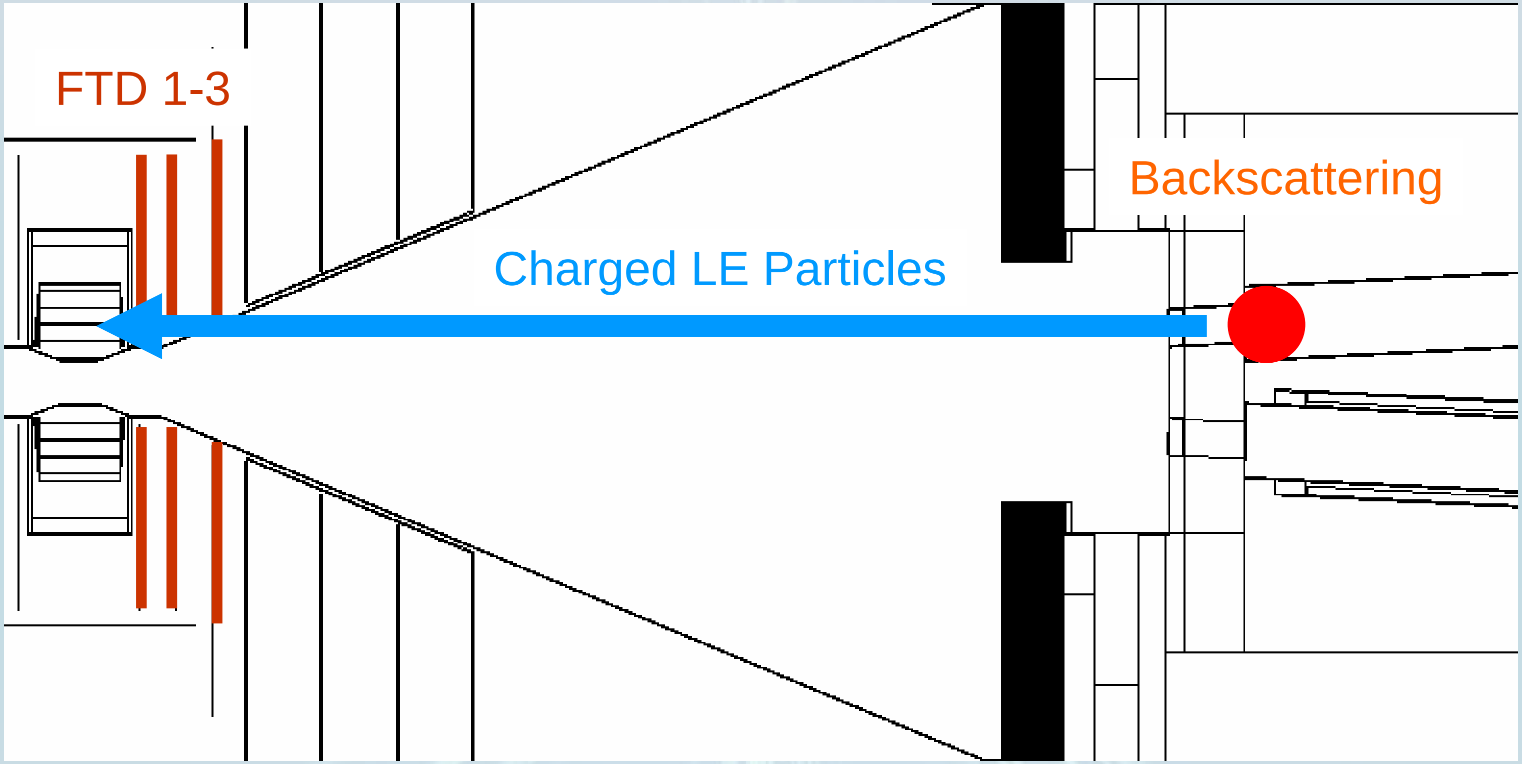
Color coding:
Photons
Electrons
Positrons





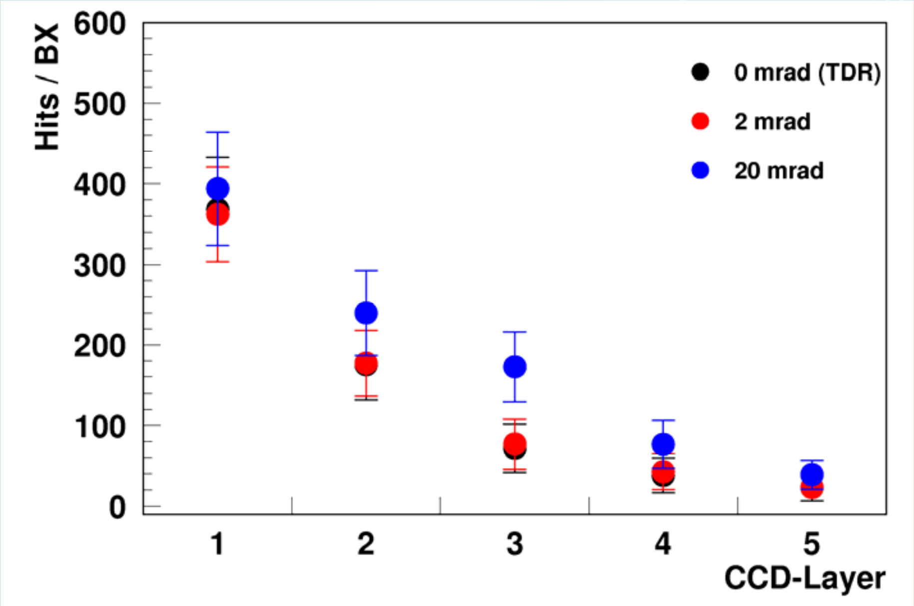


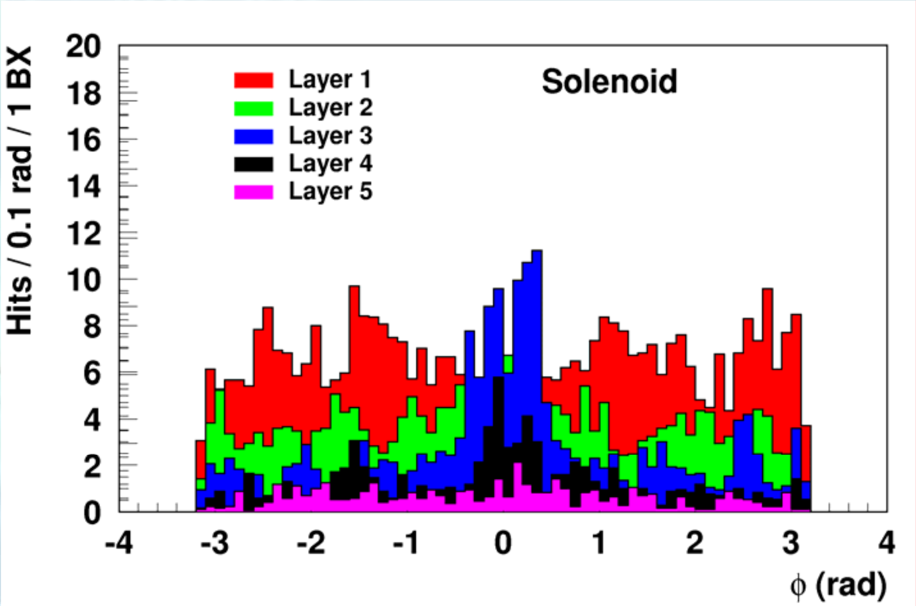
Hits on the VTX



- 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

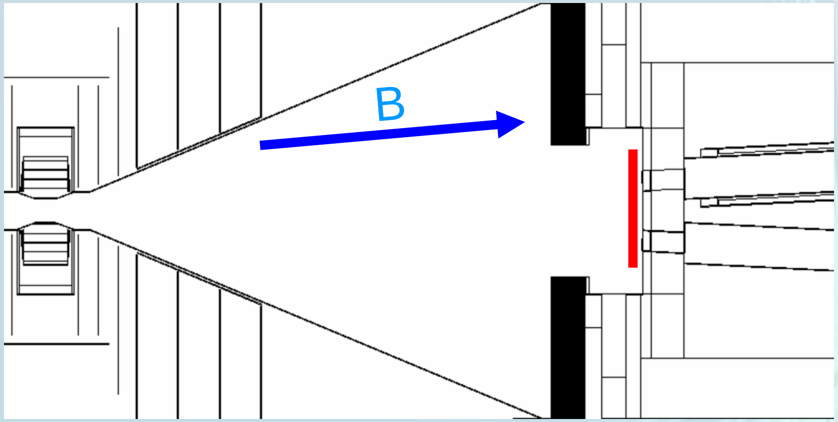


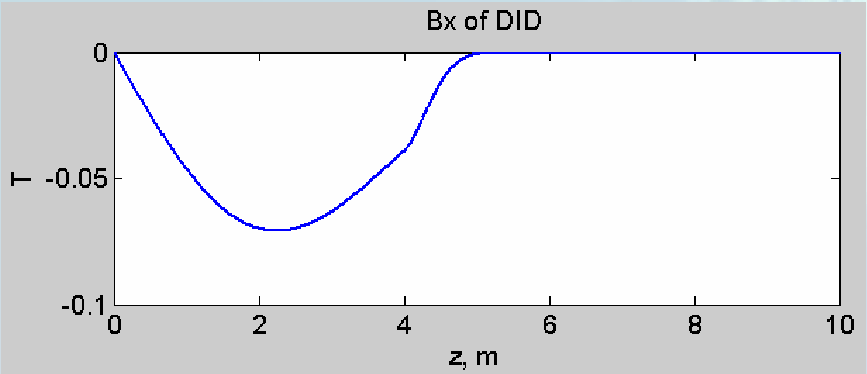


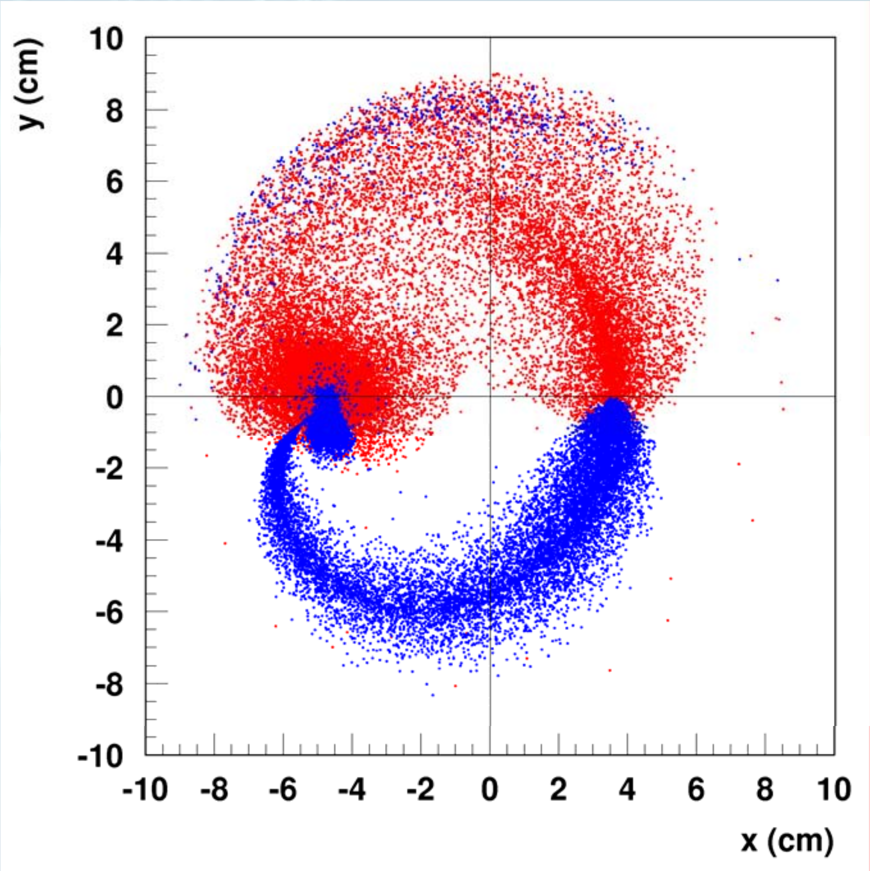
- ‘Pictures’ from the holes produce asymmetries

Pairs on the BeamCal

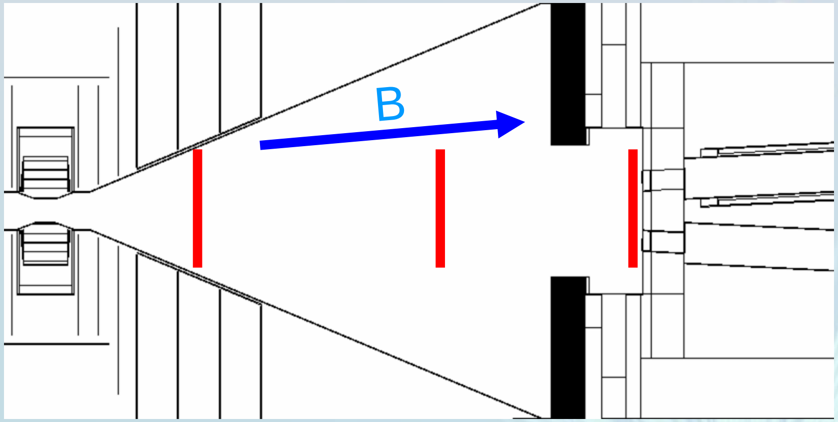
Added dipole correction field (“DID”)







Backscattering with DID



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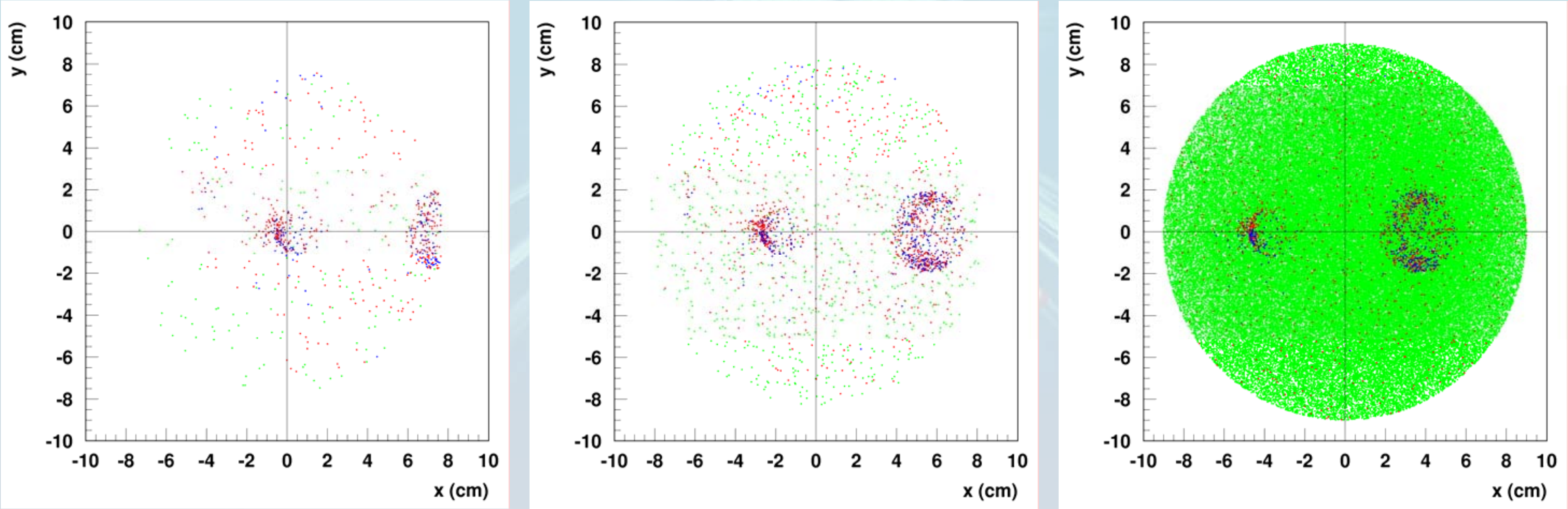
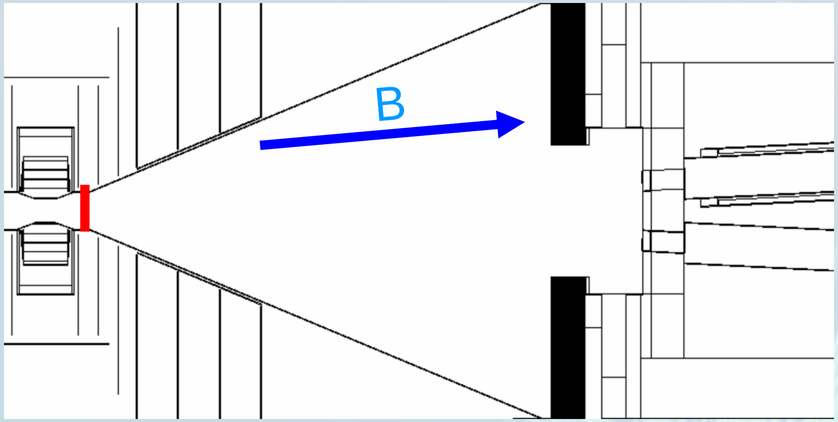


Backscattering with DID



Color coding:
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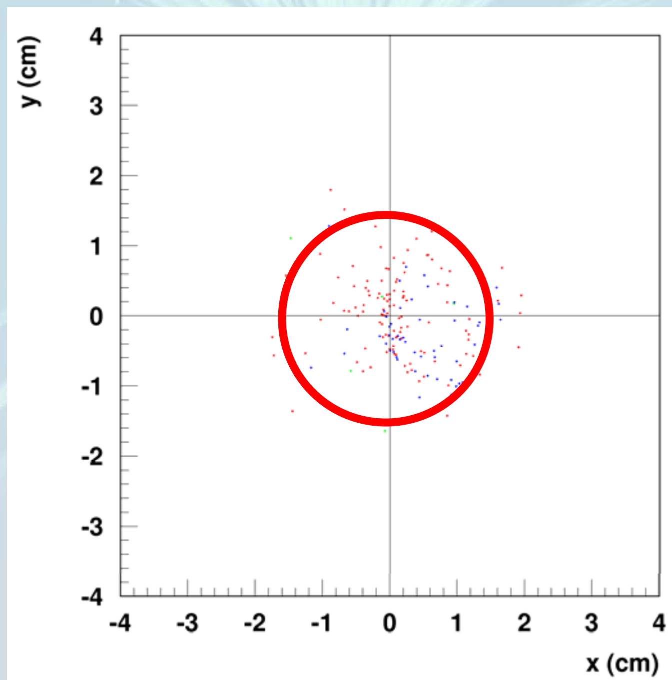
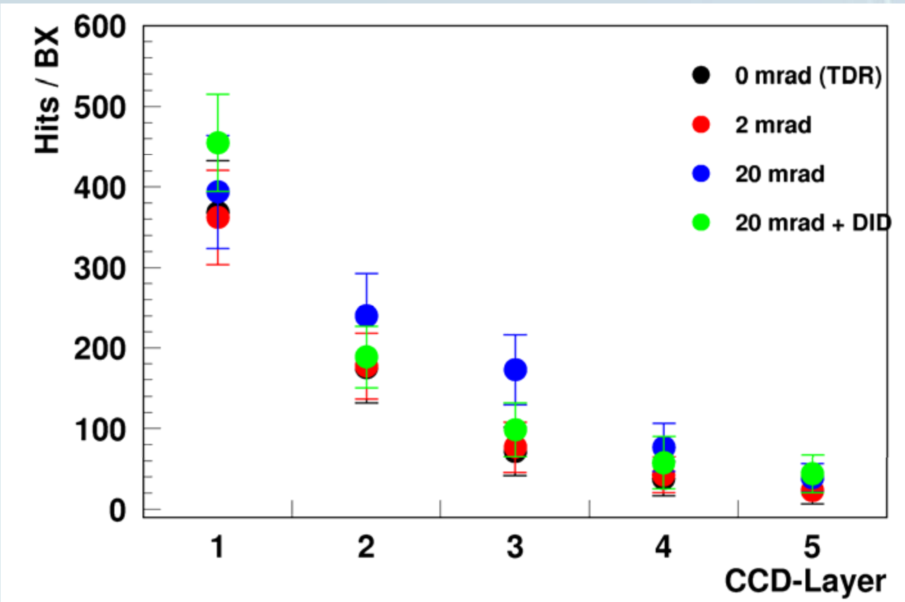
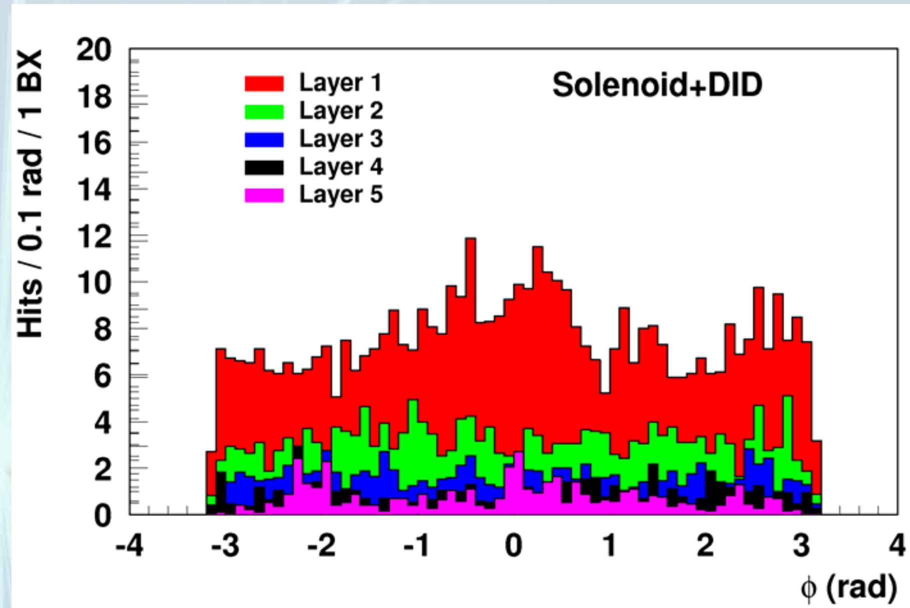


Inner VTX layer

Hits on the Vertex Detector with Solenoid+DID, 20 mrad





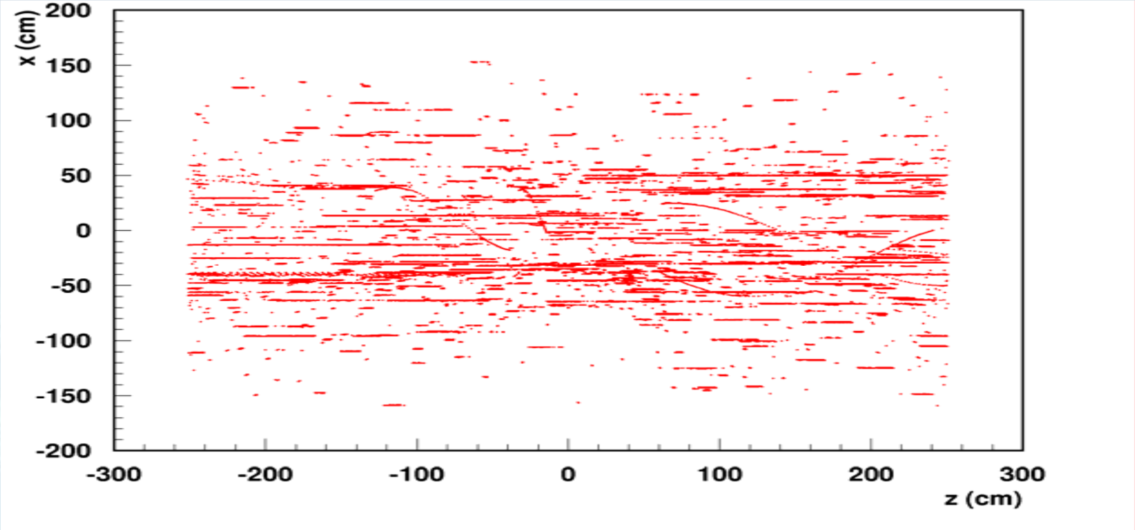
Realistic DID:

- guides charged particles from exit hole away from outer layers
- guides charged particles from incoming hole into layer 1

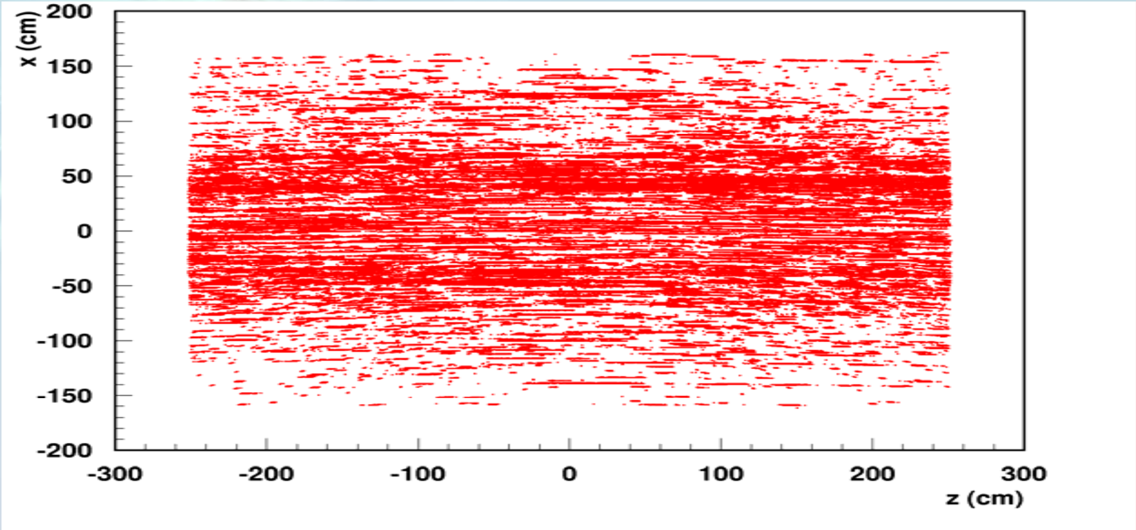
→ though the effect is small here, that is potentially dangerous!

Hits in the TPC

Solenoid field:
3304 ± 704 Hits/BX

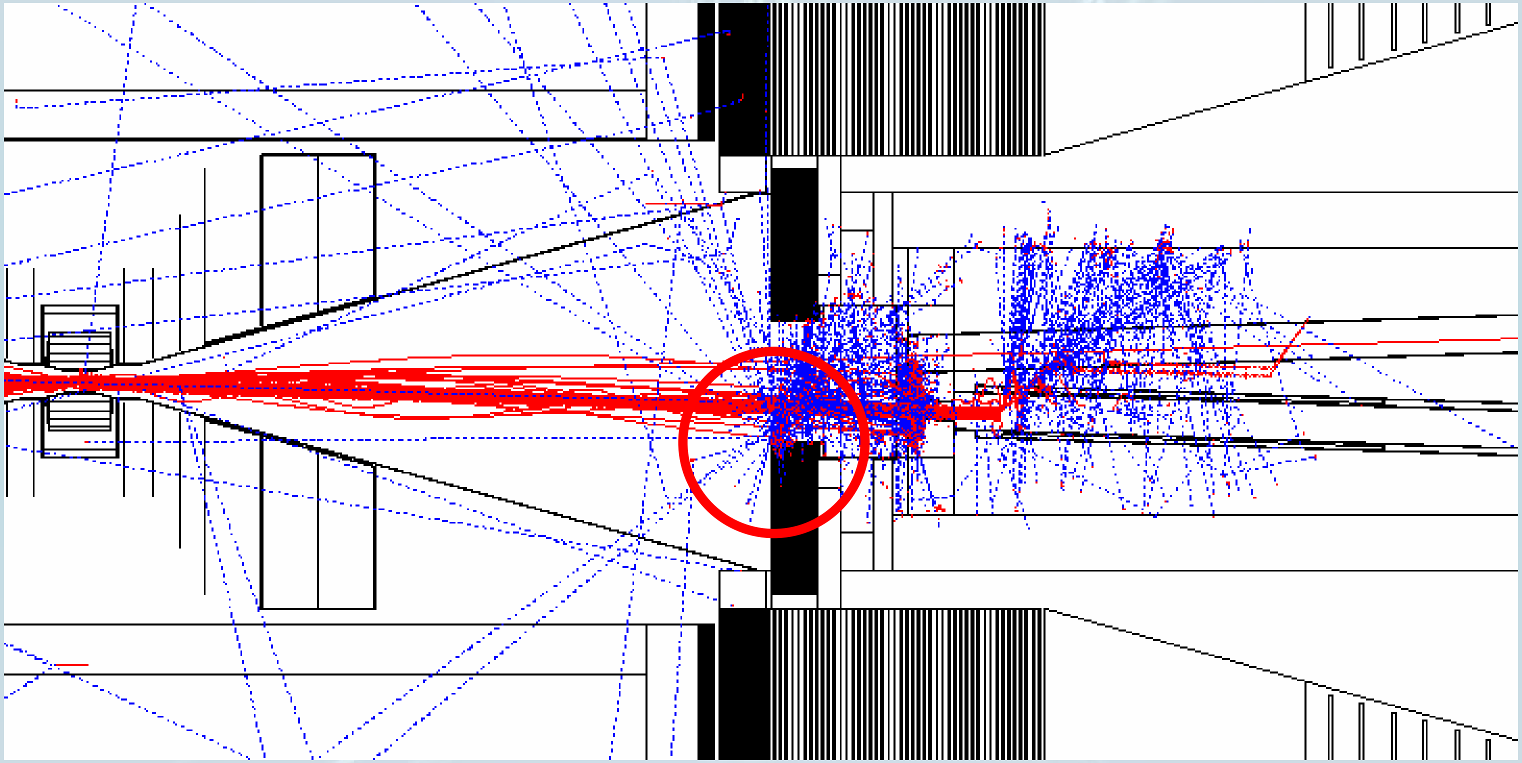


Solenoid+DID field:
18145 ± 2518 Hits/BX



Plots show hits of 17 BX overlaid

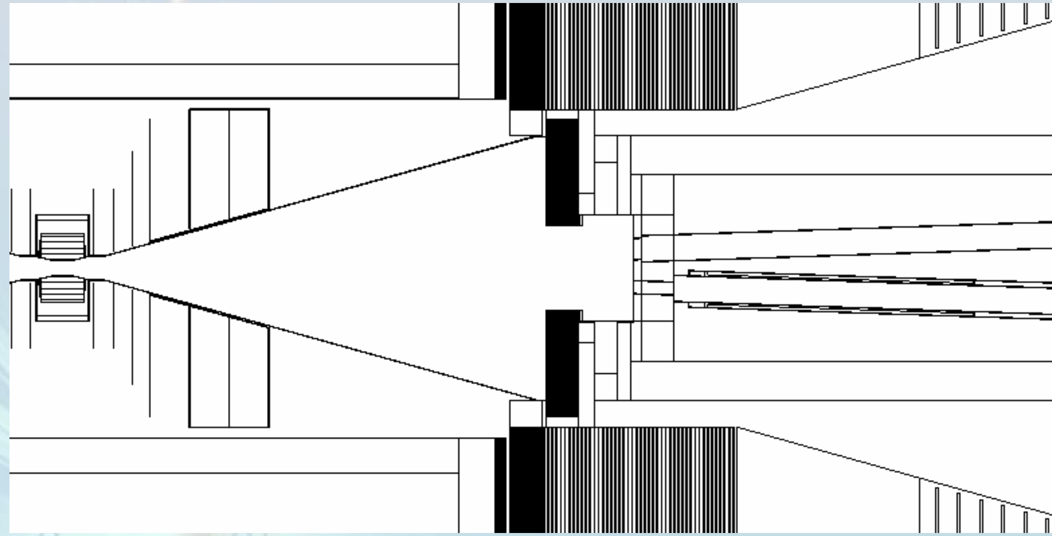
Origin of TPC Photons with Solenoid+DID



Pairs hit edge of LumiCal

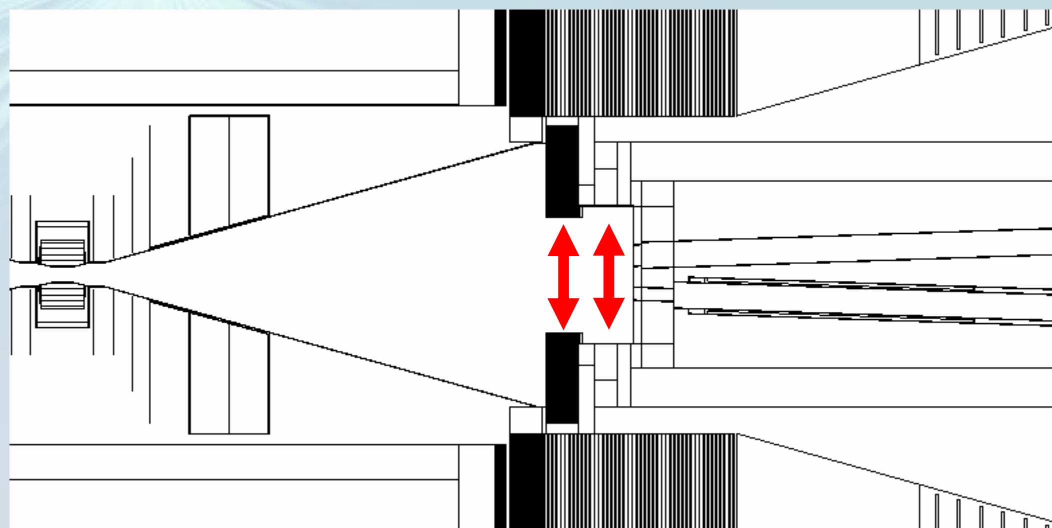
First Try for a Fix

Original geometry



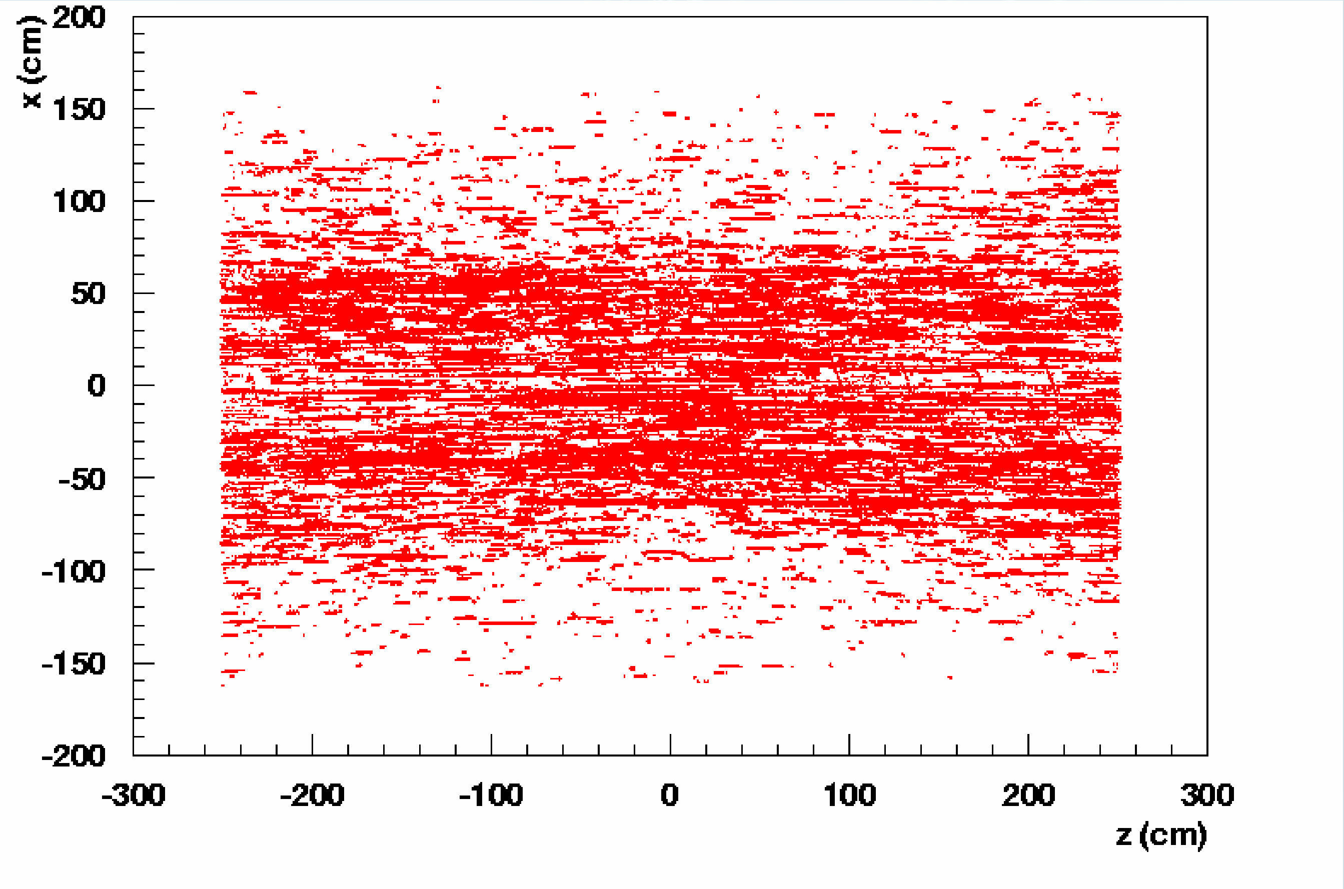
New geometry:

- increased aperture of LumiCal by 3 cm
- increased outer radius of BeamCal by 3 cm
- increased apertures in between accordingly



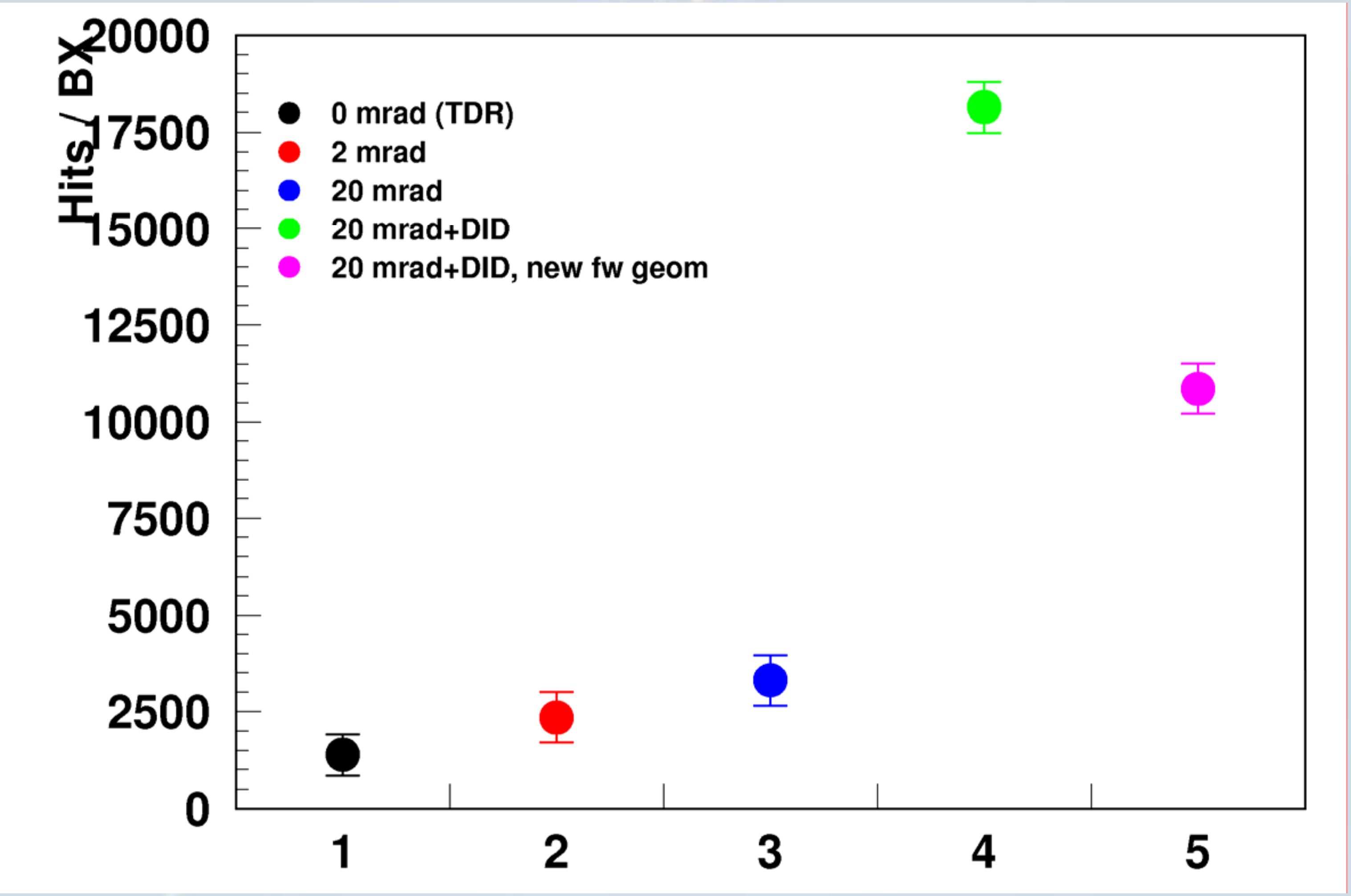
Hits in the TPC – New Geometry

10861 ± 1840 Hits

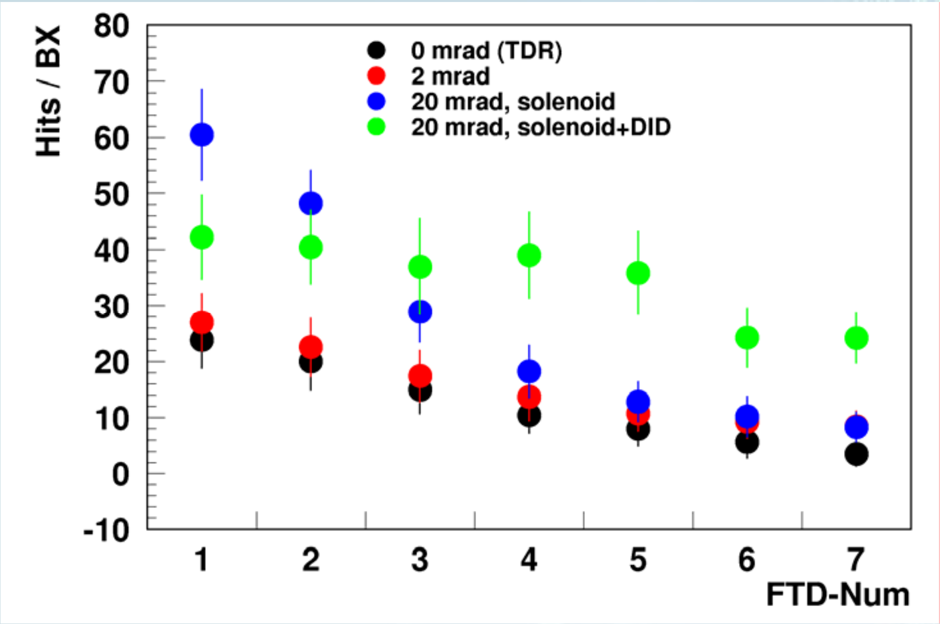


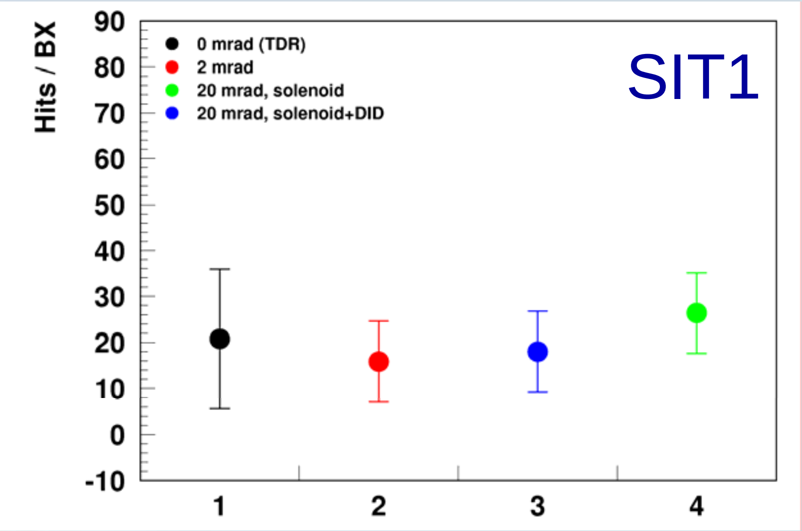
Larger opening angle of the mask results in more backscattering into the TPC

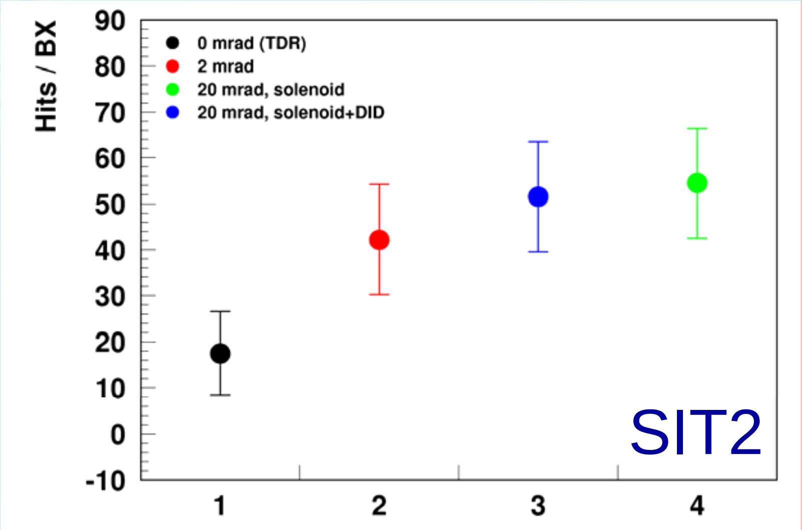
Hits in the TPC Summary



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
  - increase backgrounds in the TPC (and the forward chambers) by a factor of 4 compared to pure solenoid field configurations, this is a factor of 6 above the 2 mrad case and a factor of 10-12 above the TDR head-on case
  - 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!