The TPC/HBD Simulation Package in PISA

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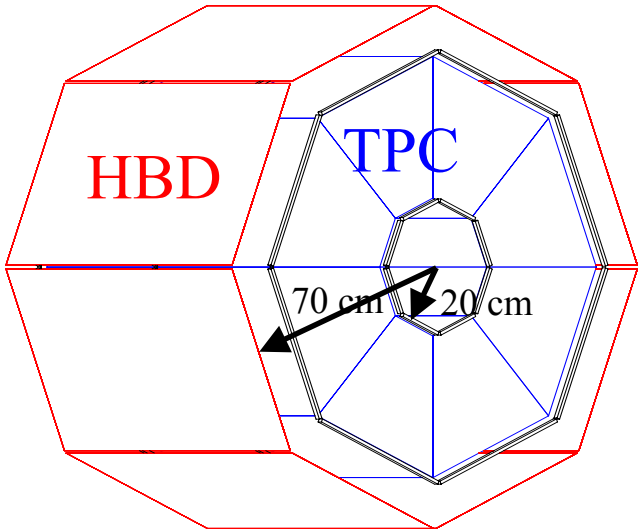
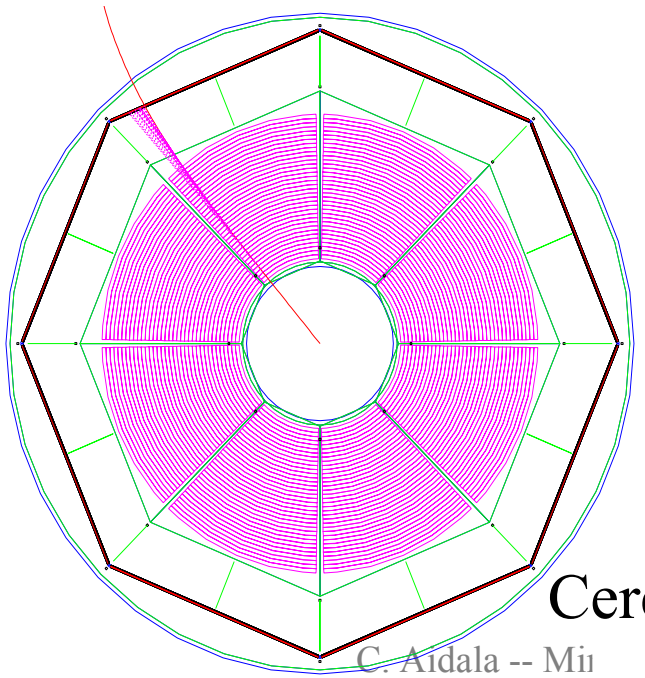
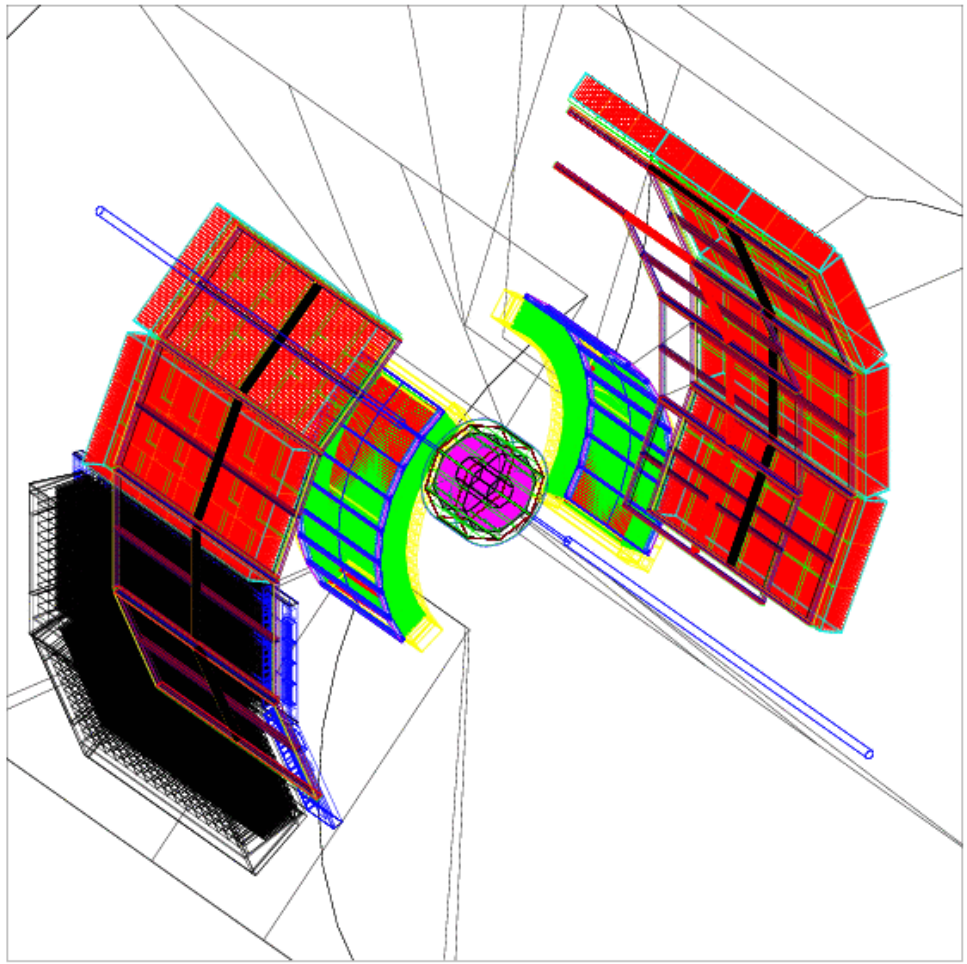






Cerenkov radiation from 100 MeV e^-

What has been done with it so far?

- Occupancy studies
- Cerenkov blob size, # photoelectrons
  - CH_4 and CF_4 both implemented as gas options
  - Blobs in various field configurations
- Multiplicity and conversion studies (with Si upgrade)
  - Combinatorial background studies: see K. Ozawa's talk
- A first look at dE/dx

Occupancy of TPC

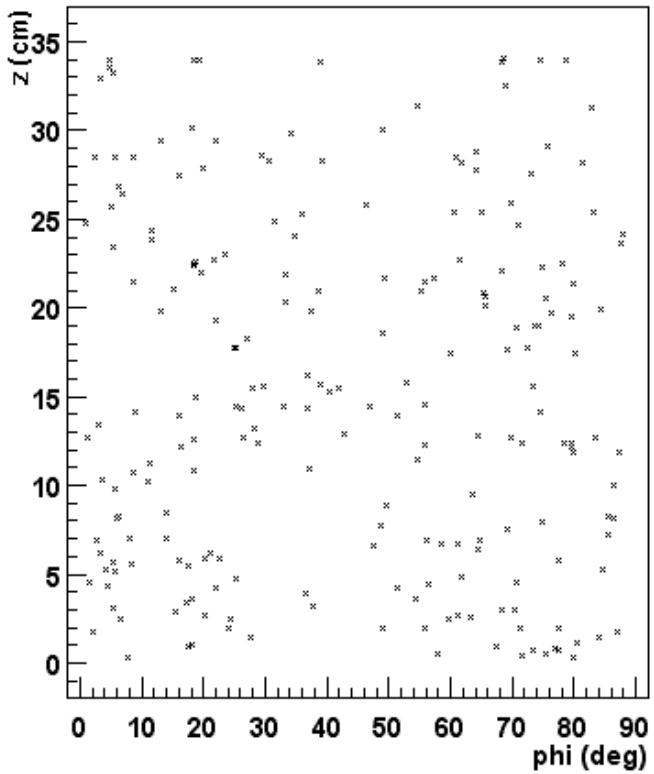
Central Au-Au ($dN_{ch}/dy = 650$) at 200 GeV

Assume 2x10 mm^2 pads on readout planes

Innermost pad row (r = 20 cm)

90^o = 157 divisions in ϕ

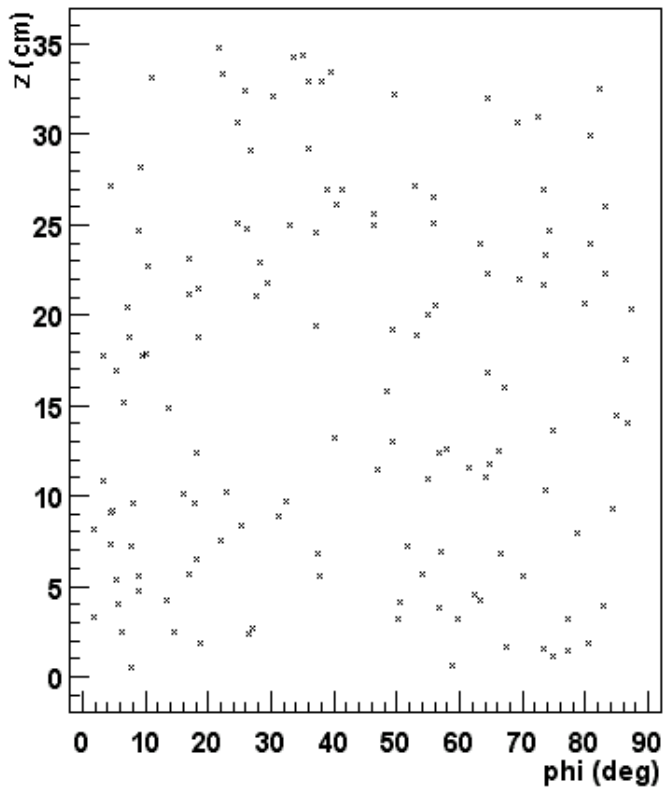
199 hits



Midrange pad row (r = 35 cm)

90^o = 275 divisions in ϕ

137 hits

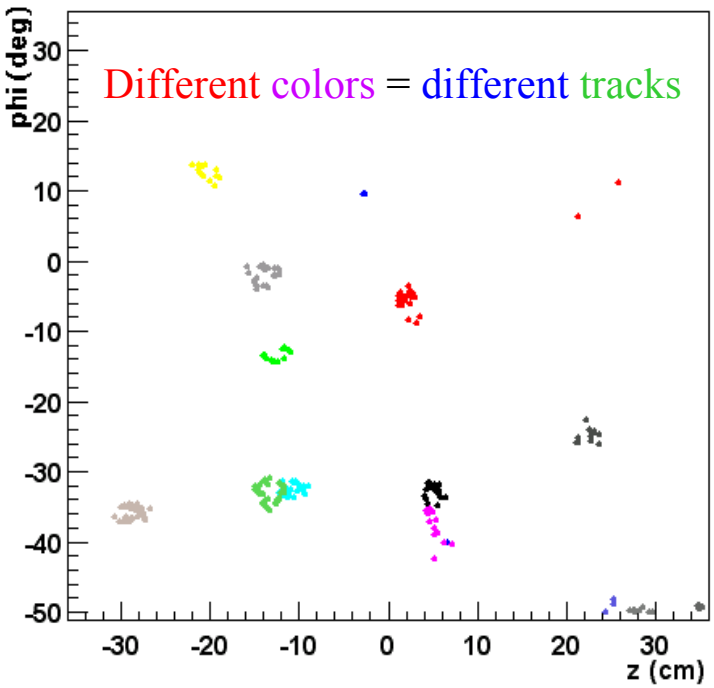


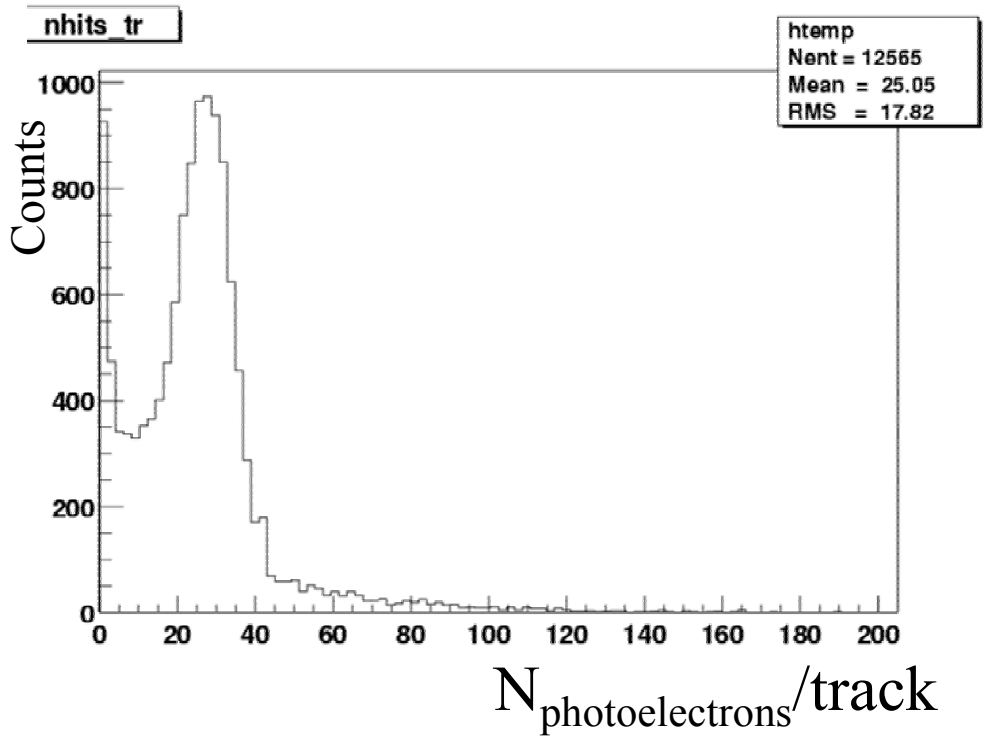
HBD Occupancy, Blob Size

Occupancy of HBD

Assuming 4% of a radiation length from proposed silicon vertex detector upgrade

CF_4: ~30 photoelectrons per e^- track
Blob diameter ~5 cm with zero-integral field



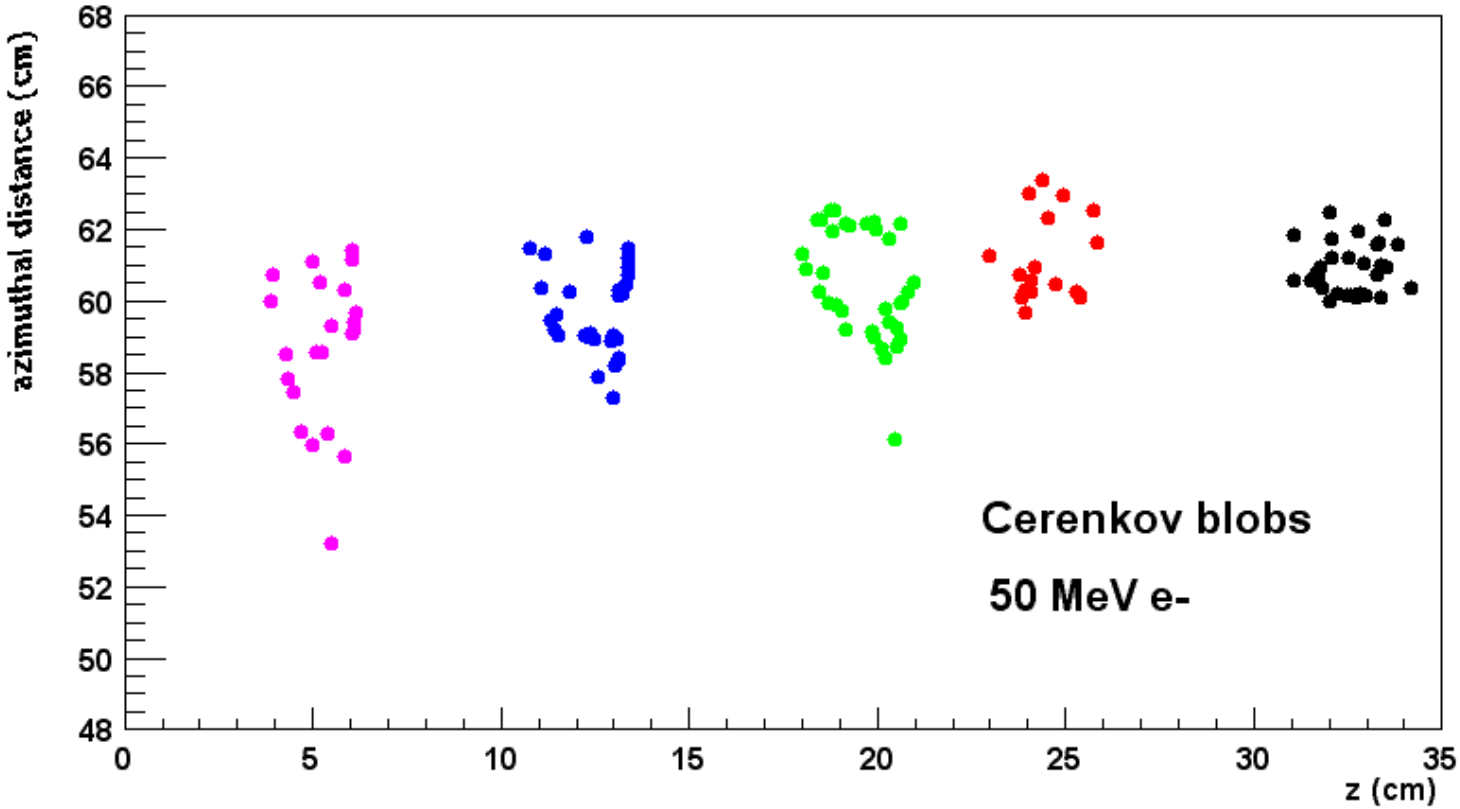


Central Au-Au ($dN_{ch}/dy = 650$)

θ-dependence of blob spread

50 MeV e- at different θ, zero-integral field

65° 70° 75° 80° 85°

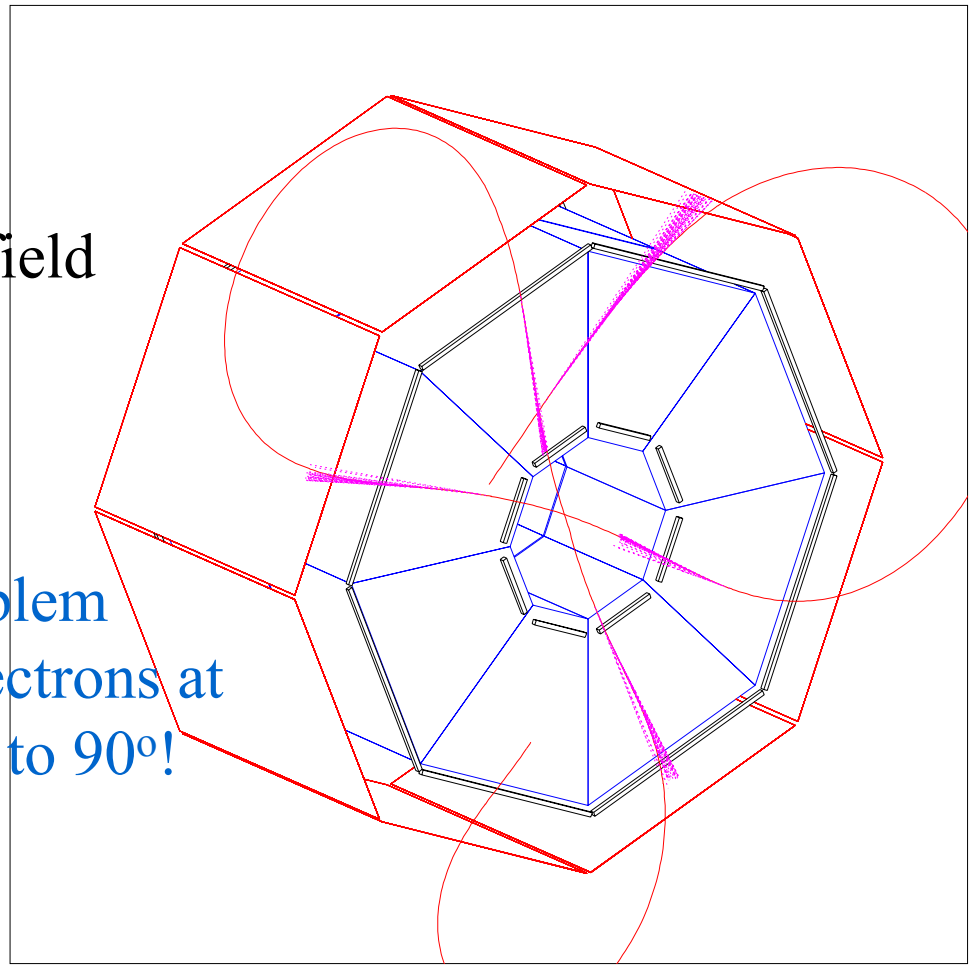


Looking at a limited ϕ region

50 MeV e^- getting turned around in the outer PHENIX field

$\theta = 85^o$

Zero-integral field



Turnaround a problem for low-energy electrons at polar angles close to 90^o!

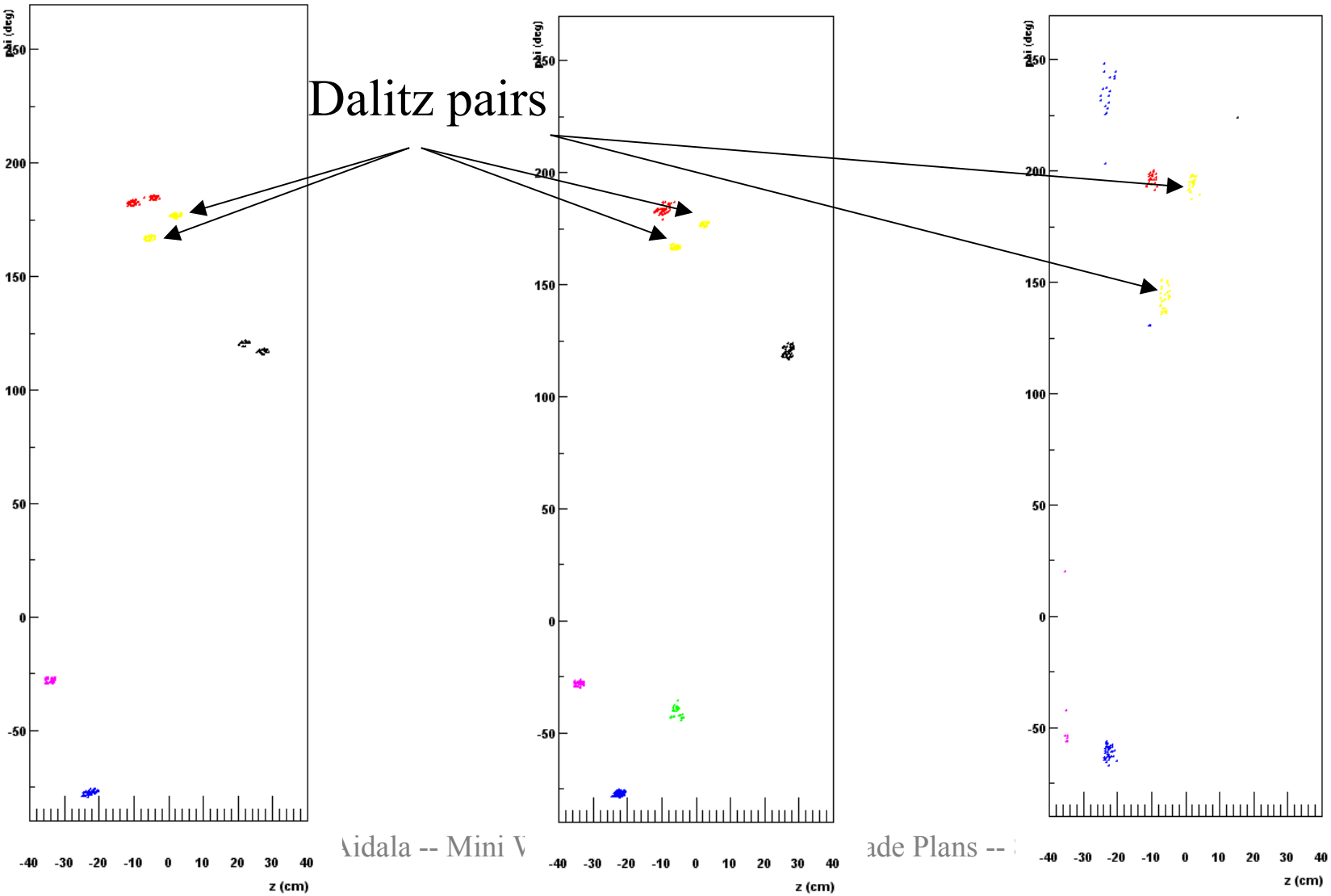
Dalitz pair Cerenkov blobs in different fields

No field

Zero-integral

Strong (additive)

Dalitz pairs



Electron Multiplicities/Event

In TPC

Averaged over 200 events	No Si	Si
Tracking down to 1 MeV	33.7	89.5
Tracking down to 10 MeV	30.5	81.4
Tracking down to 20 MeV	27.0	73.5

Hitting HBD

Averaged over 200 events	No Si	Si
Tracking down to 1 MeV	28.4	59.8
Tracking down to 10 MeV	25.3	56.5
Tracking down to 20 MeV	22.6	51.6

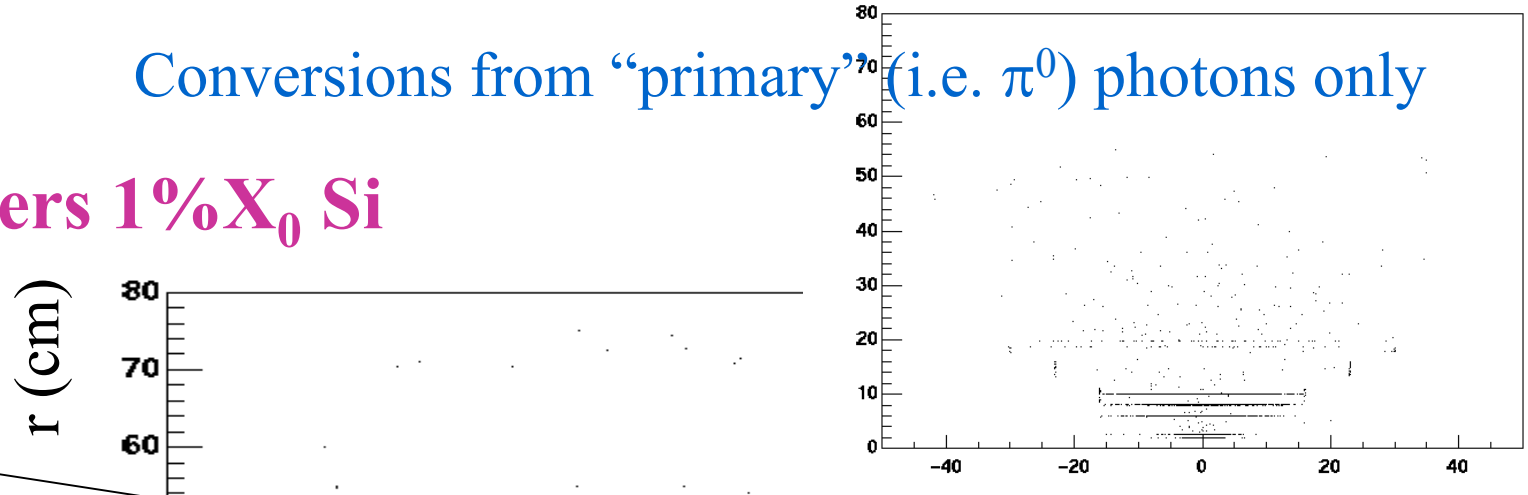
No min. hits/track required in TPC

- Zero-integral magnetic field
- 4 layers 1%X_0 Si
- 4 layers 2%X_0 Si: 89.5 → 130.4 electrons/event in TPC!

Vertex of conversion pairs hitting TPC

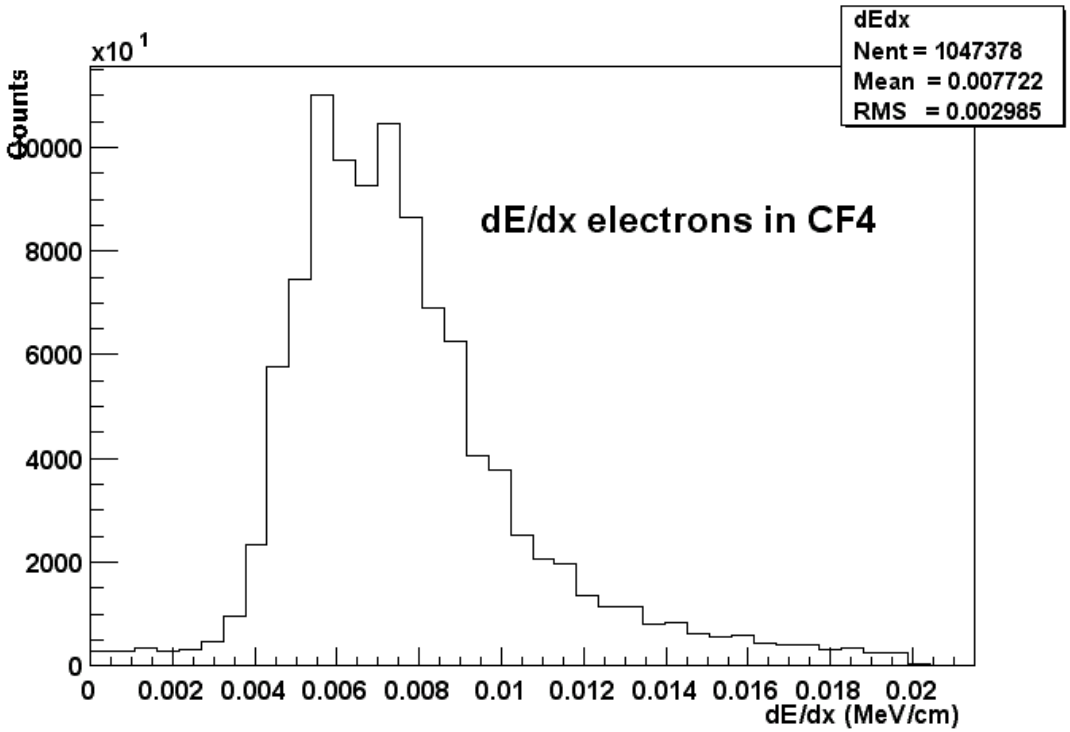
Conversions from "primary" (i.e. π^0) photons only

4 layers 1%X_0 Si



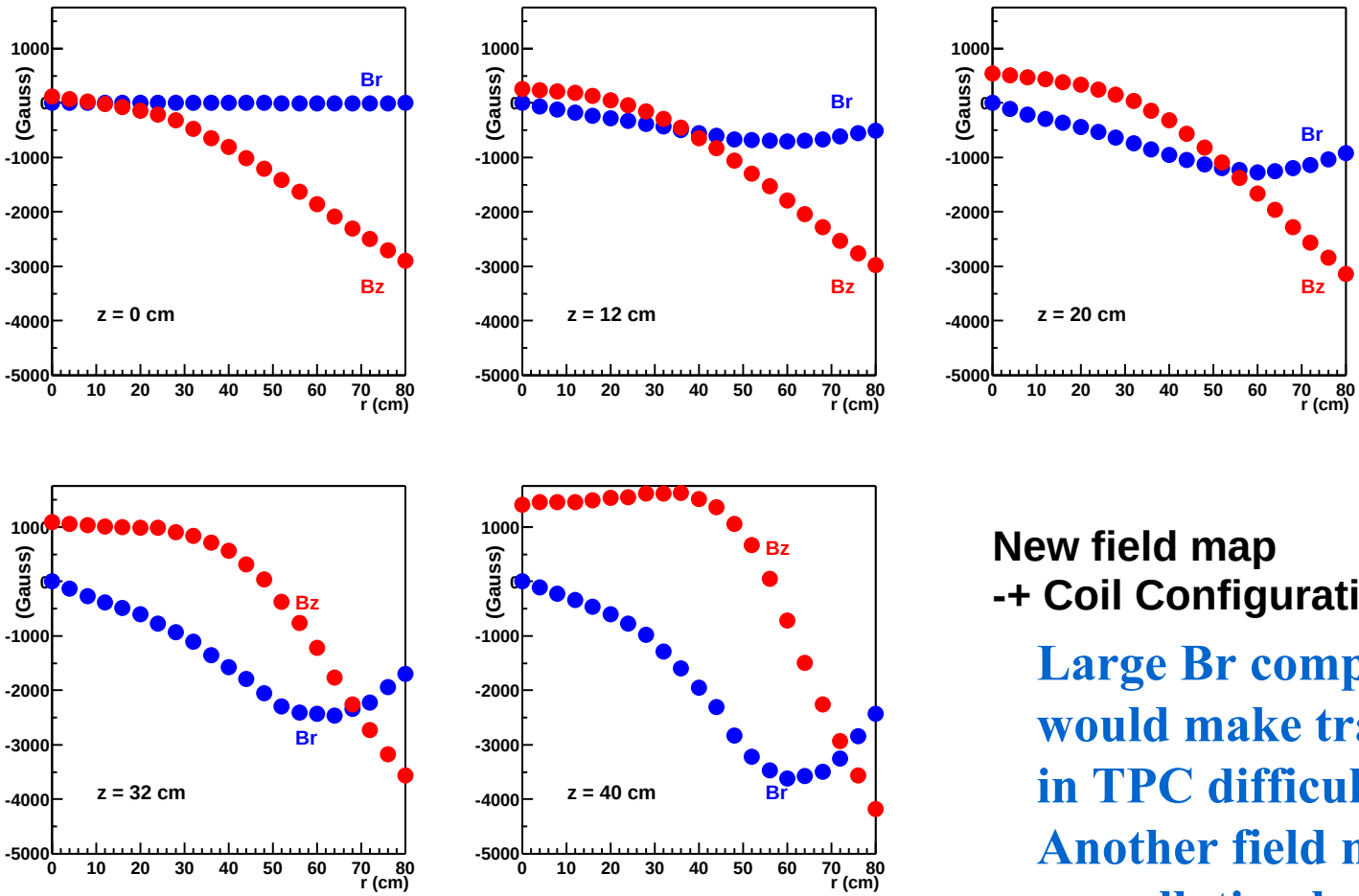
dE/dx

- A quick look at dE/dx for electrons in CF_4 according to GEANT
  - value given in Weizmann Technical Note: ~7 keV/cm



New inner field coil: low-field inner tracking region for low-momentum measurements

Even with maximum cancellation, not a field-free region



New field map
-+ Coil Configuration

Large Br components would make track-finding in TPC difficult!
Another field map with 80% cancellation has been requested.

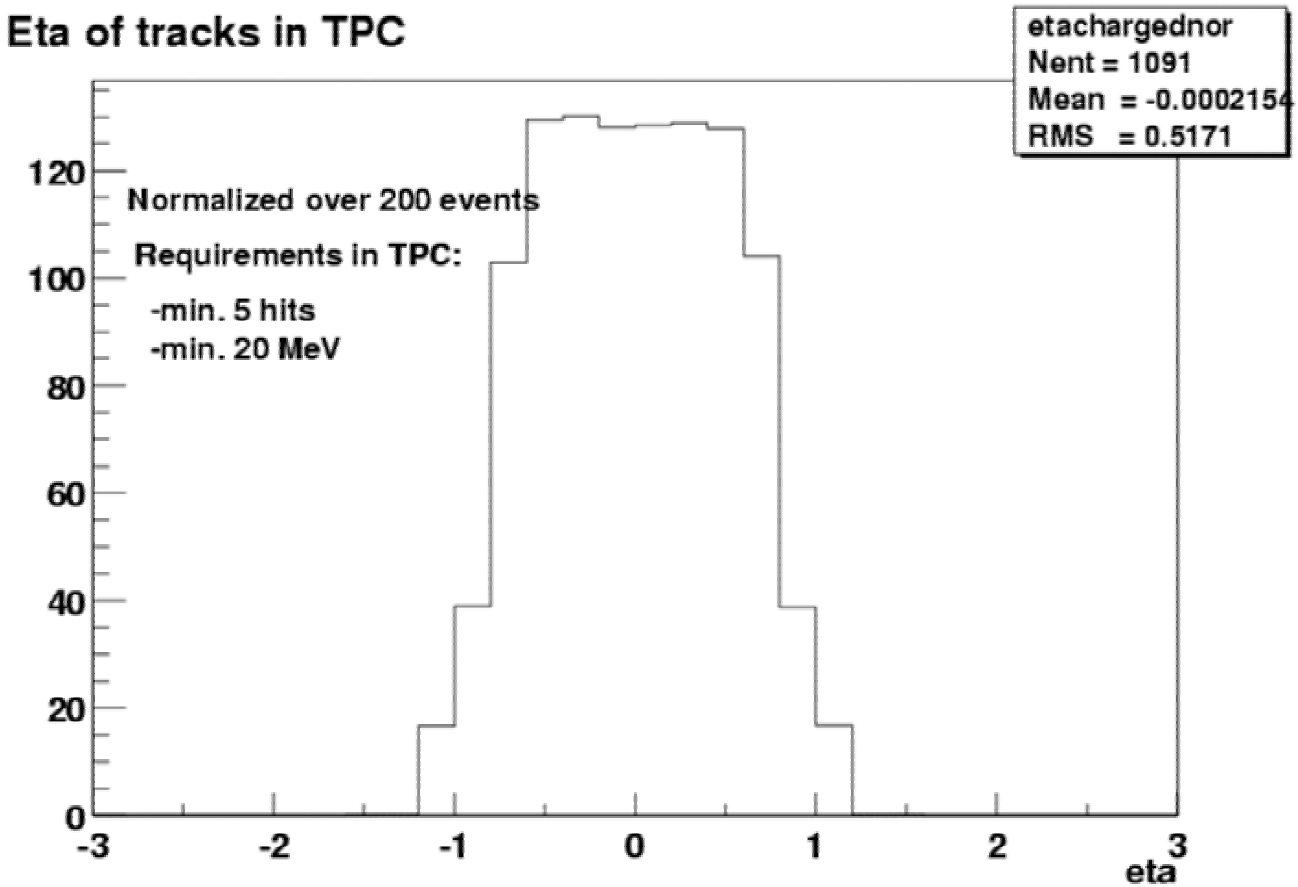
Plans for the Future

- Study track-finding and momentum resolution in TPC for various partial cancellation field configurations
  - What distortions in the tracks will there be due to ExB effects in the non-uniform magnetic field, space charge, . . .?
- More realistic detector response and readout
- Study HBD segmentation
- Investigate alternative gases/gas mixtures
- Further integration with proposed silicon upgrade detector

Various documentation on the TPC/HBD in PISA can be found at
http://www.phenix.bnl.gov/phenix/WWW/p/draft/caidala/documentation/hbd_tpc/

Spare Slides

TPC Acceptance

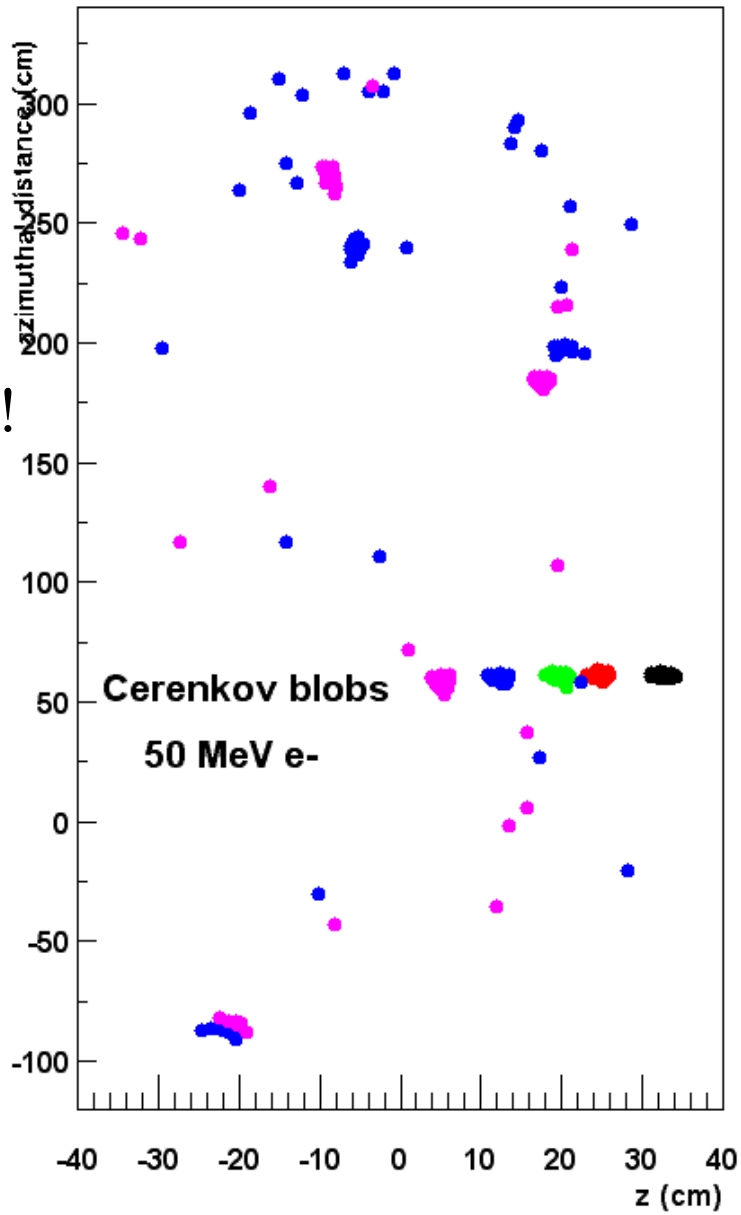


50 MeV e^- at different θ

Looking at full azimuthal coverage.
The particles at 80 and 85° are exiting and re-entering multiple times!

65° 70° 75° 80° 85°

Zero-integral field

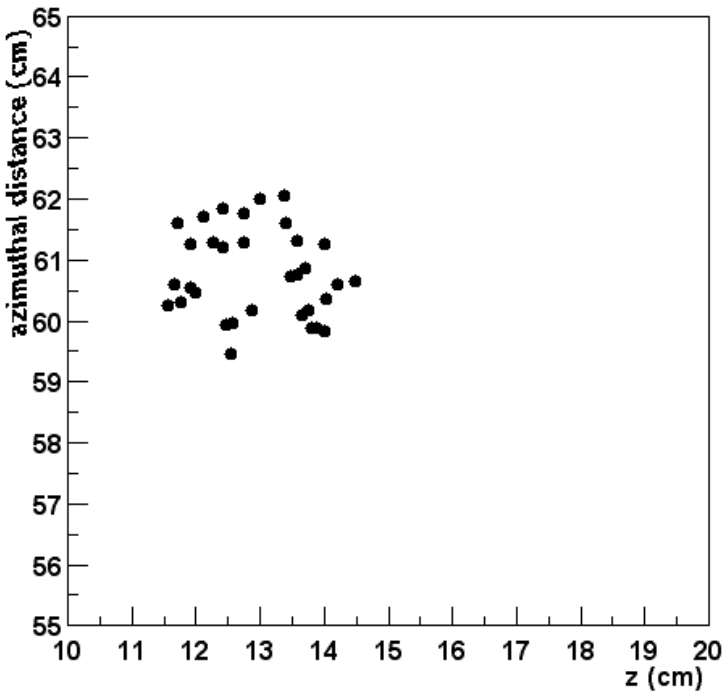


How does the field affect the Cerenkov blobs on the HBD?

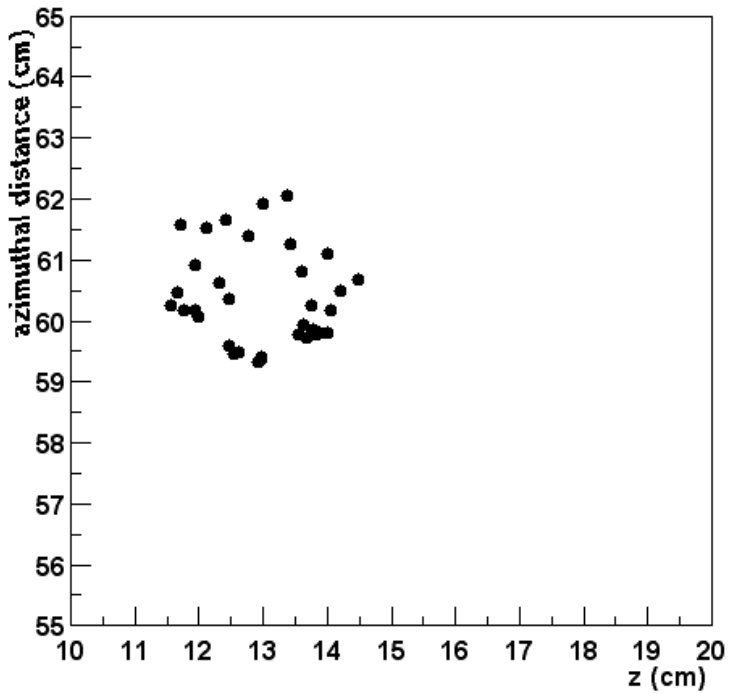
CH_4 radiator

200 MeV e^- : Little effect

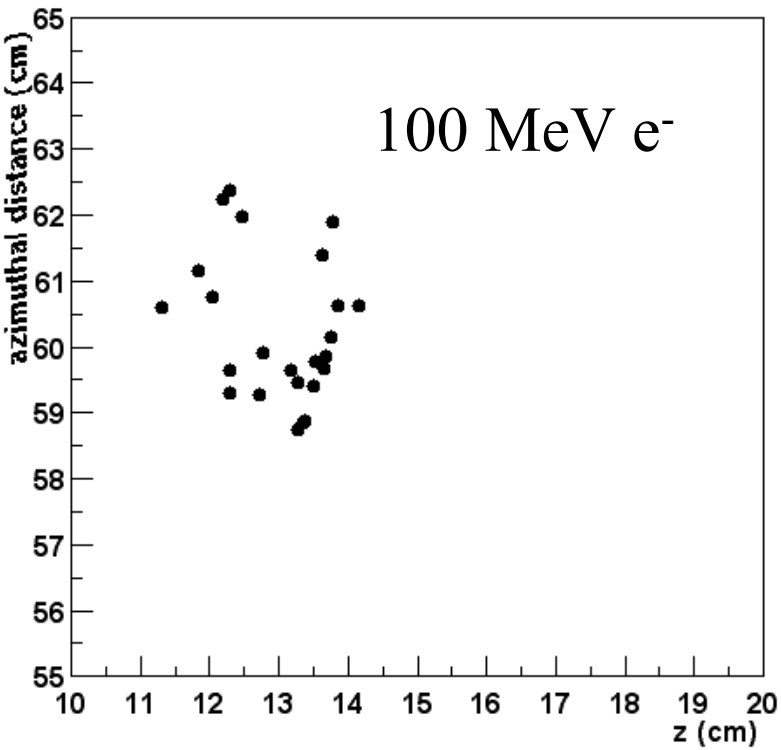
No field

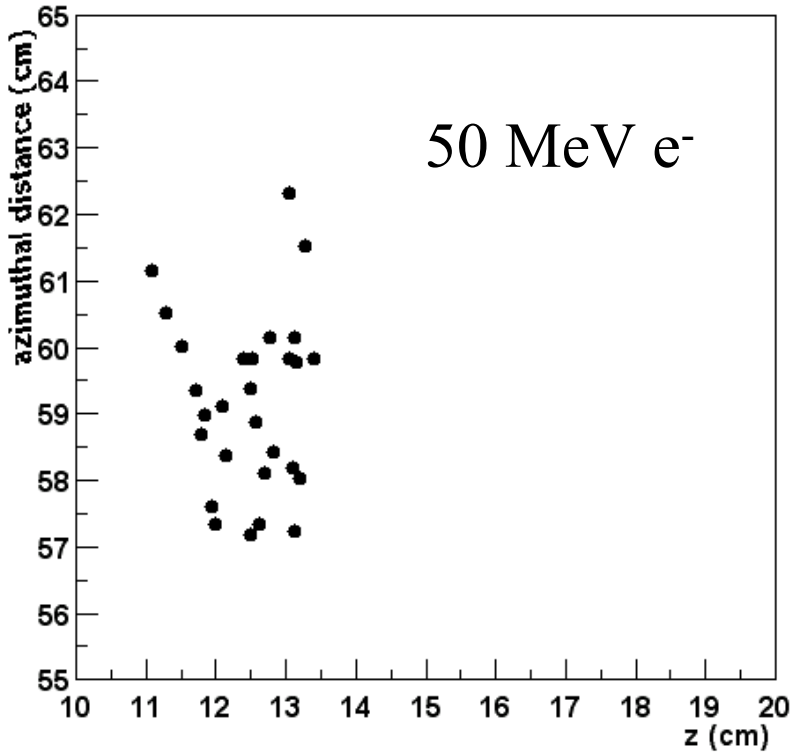


Zero-integral field



With zero-integral field





e+- Multiplicities/event: Effect of no field

No min. hits/track required in TPC

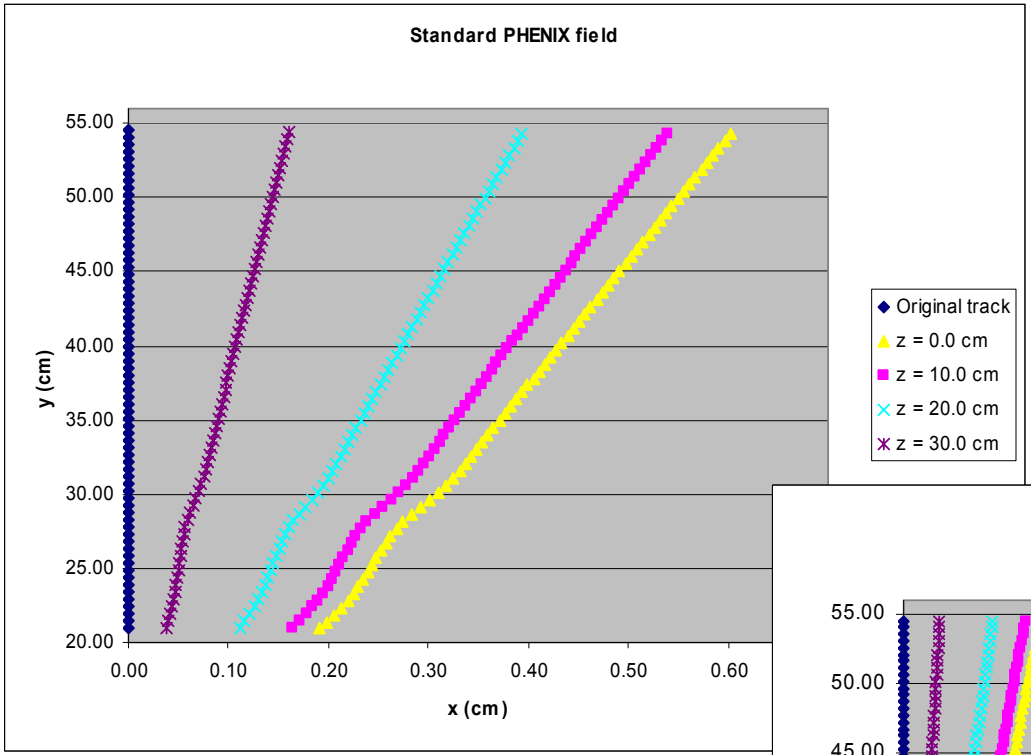
TPC

Averaged over 200 events	No Si	Si
No field (Tracking down to 1 MeV)	24.4	80.2
Field (Tracking down to 1 MeV)	33.7	89.5

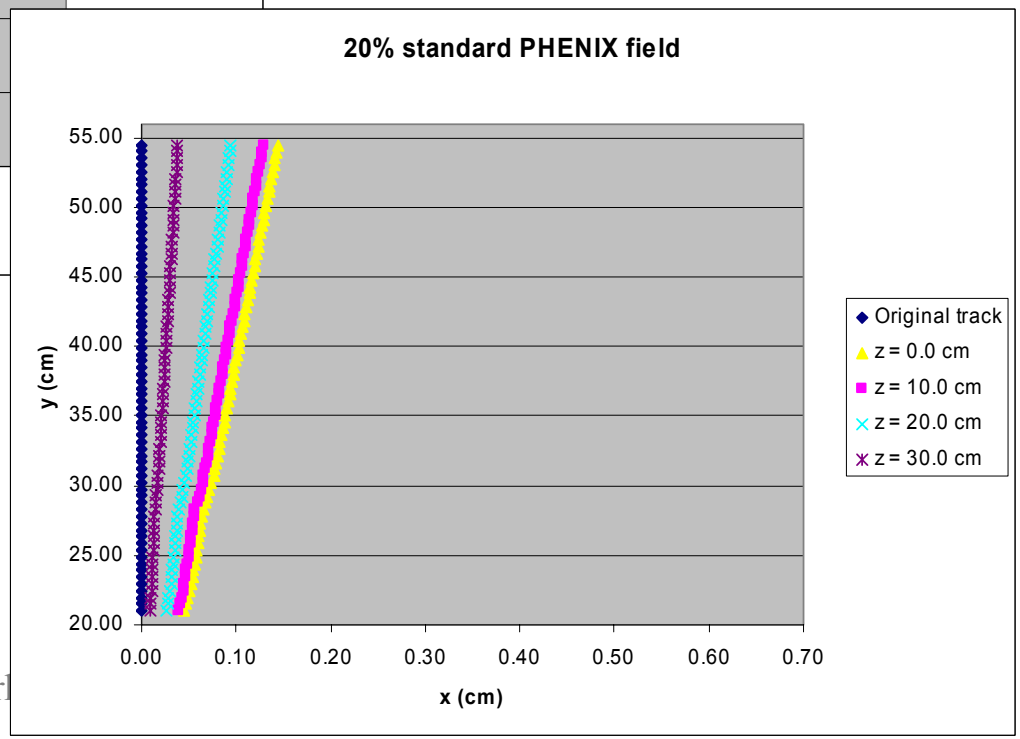
HBD

Averaged over 200 events	No Si	Si
No field (Tracking down to 1 MeV)	19.5	50.1
Field (Tracking down to 1 MeV)	28.4	59.8

Track distortions due to ExB effects



- Drift out to |z| = 35 cm
- Electric field 1000 V/cm
- Standard PHENIX B field



Simulated using adapted standalone STAR code written by Jim Thomas