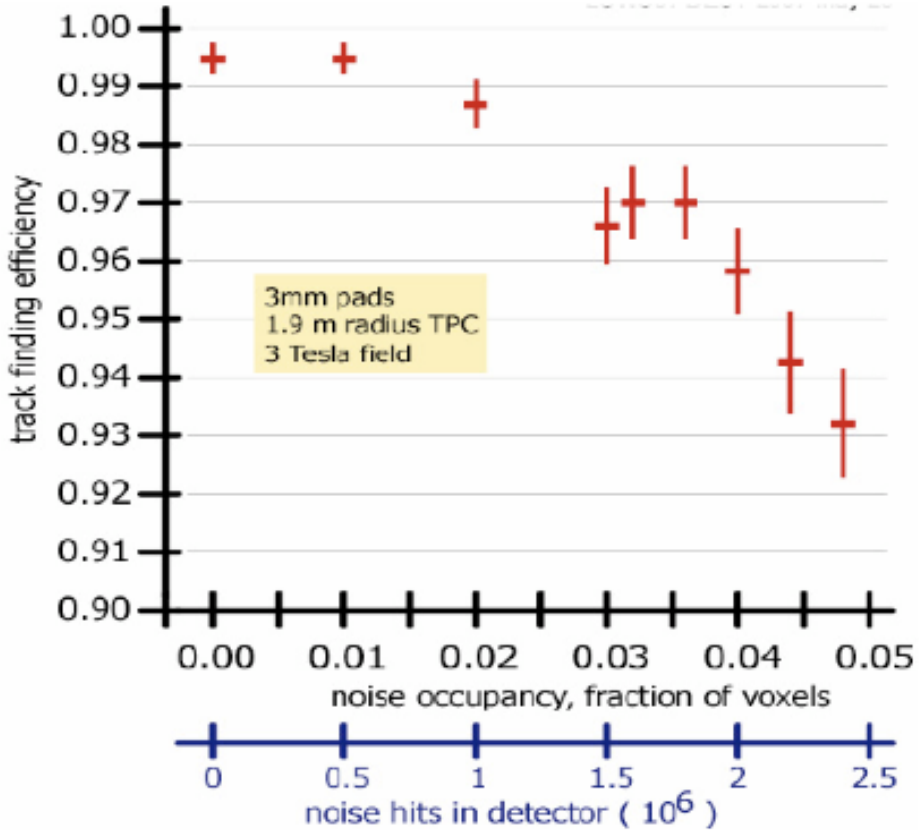
# Background Studies in the TPC for IDAG

Steve Aplin and Frank Gaede
DESY

ILD Optimisation Meeting
20th May 2009

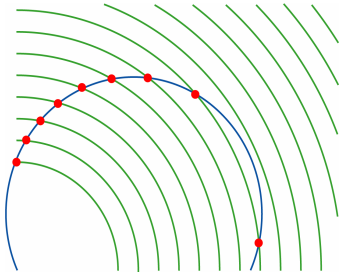
# IDAG Question

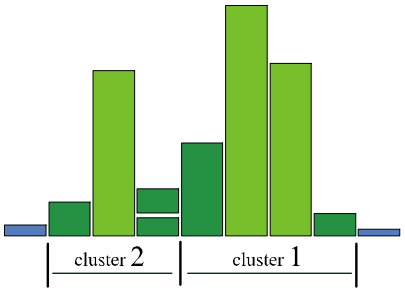


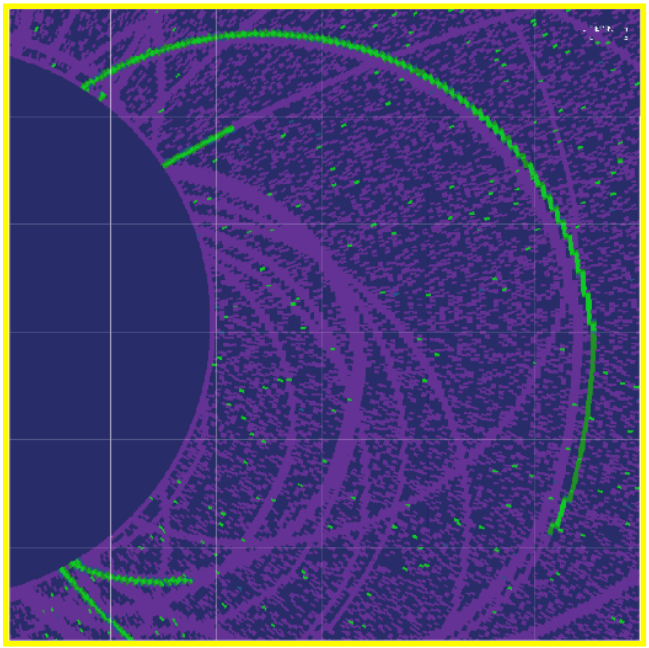

Q. Elaborate on the meaning of the information in Fig. 4.3-4. What are the plans to mitigate the loss of track efficiency with the background level? What is the sensitivity to beam halo, and at what level does it become problematic?

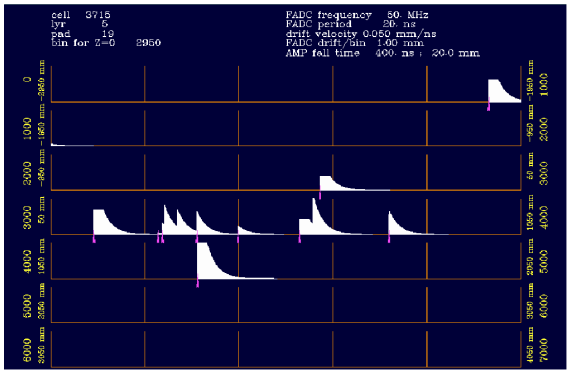
# Input to Figure 4.3-4

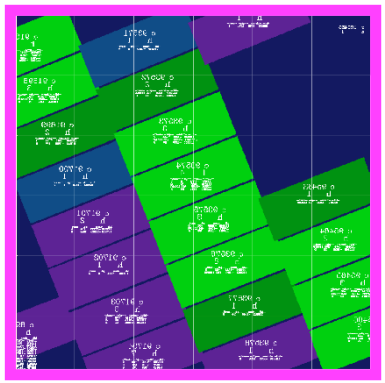
Dan Peterson performed sophisticated studies on TPC hit response, and the effect of varying levels of random noise in the TPC on tracking efficiency. Tracking Software used was that used for CLEO which Dan himself wrote. Therefore a good well understood starting point.









# Input to Figure 4.3-4

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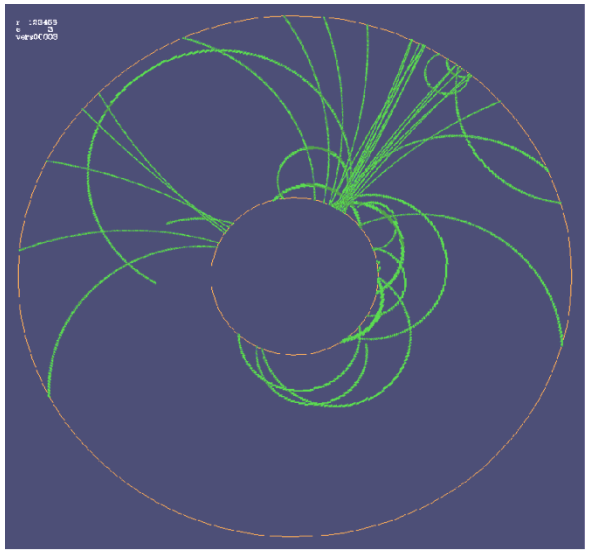
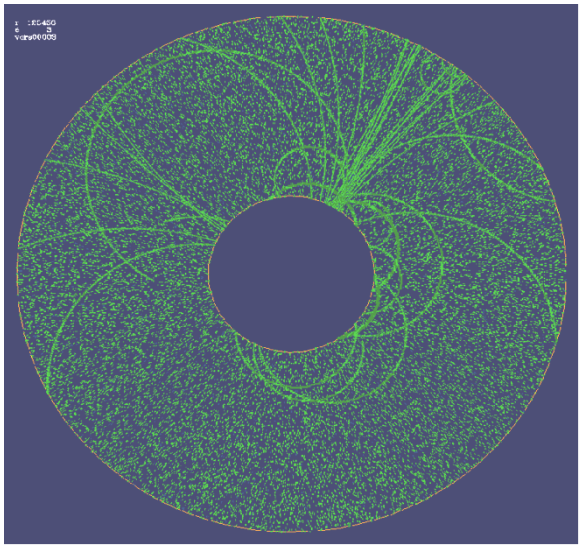
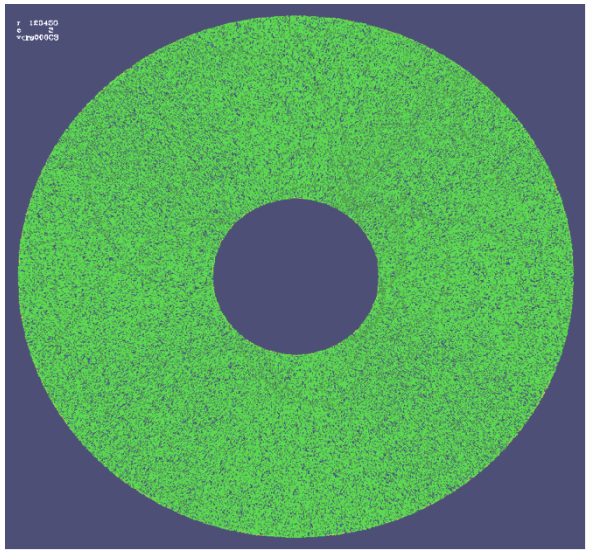
But the background was random – i.e. worst possible scenario



2 mm cells, no noise



2 mm cells, 30 K noise hits



2 mm cells, 300 K noise hits

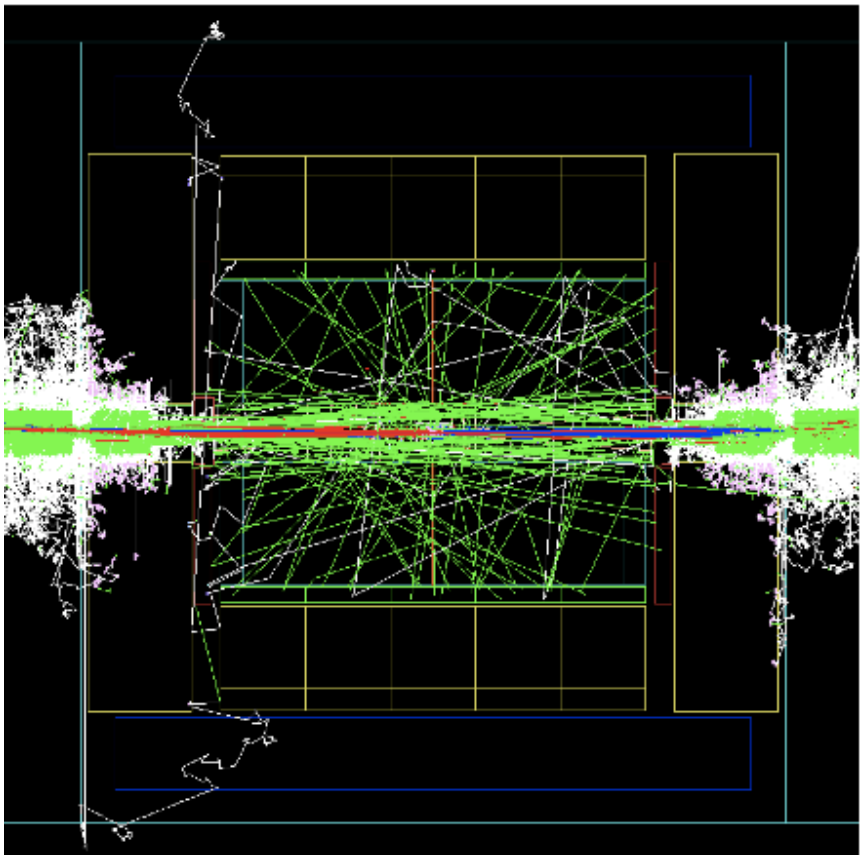
# Background – Adrian's Studies

Full GEANT-4 Simulation of pairs background including realistic description of the forward region and the magnetic fields

Main gaseous tracker conversion of backscattering photons

Tracks from the IP, rare, but mostly curlers

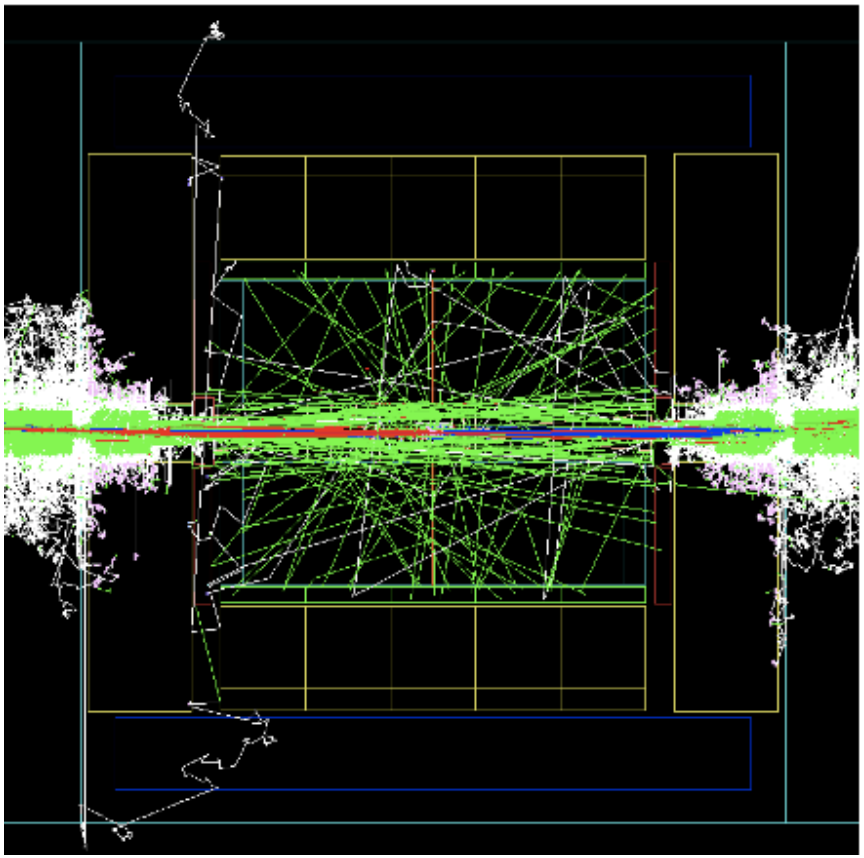
Recoil tracks from neutron-proton collisions (CH4 )



# Background – Adrian's Studies

Not included:

- Beam Halo Muons
- Beam gas interaction
- Synchrotron radiation from beam delivery
- Particle losses in extraction line
- Beam dumps



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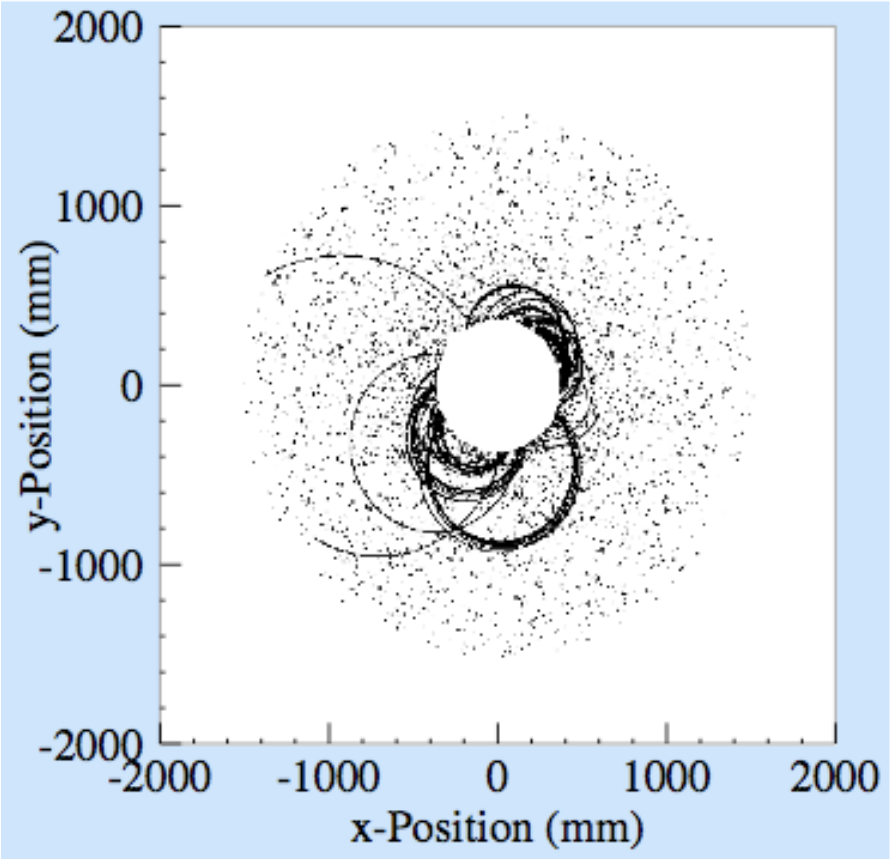
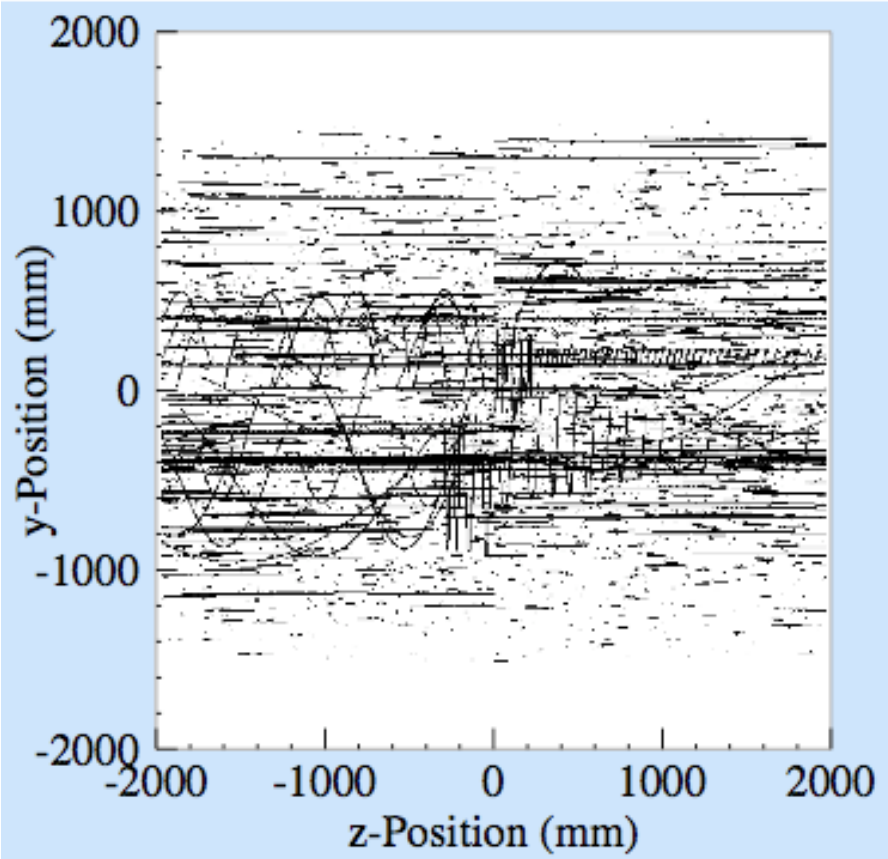
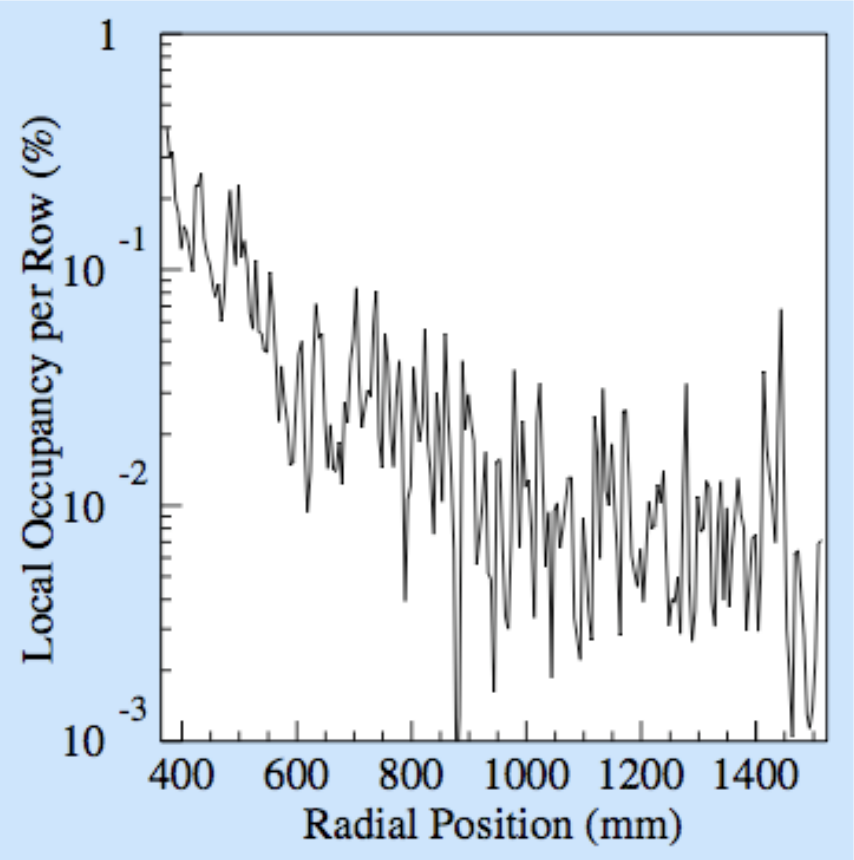



Mokka hits in the TPC (overlay of 100BX)

# Background – Adrian's Studies




Overall value stays very well below 1%

n-p scattering gives negligible contribution

though modelling of neutrons is notoriously difficult

Pairs are the dominant source background

# Background

There is a very big difference between background which can be distinguished from signal, and that which can't, even if it kills a large part of your signal

e.g. filling up the TPC with 10% noise occupancy, or removing 10% of all hits from tracks, will present two very different problems to the pattern recognition

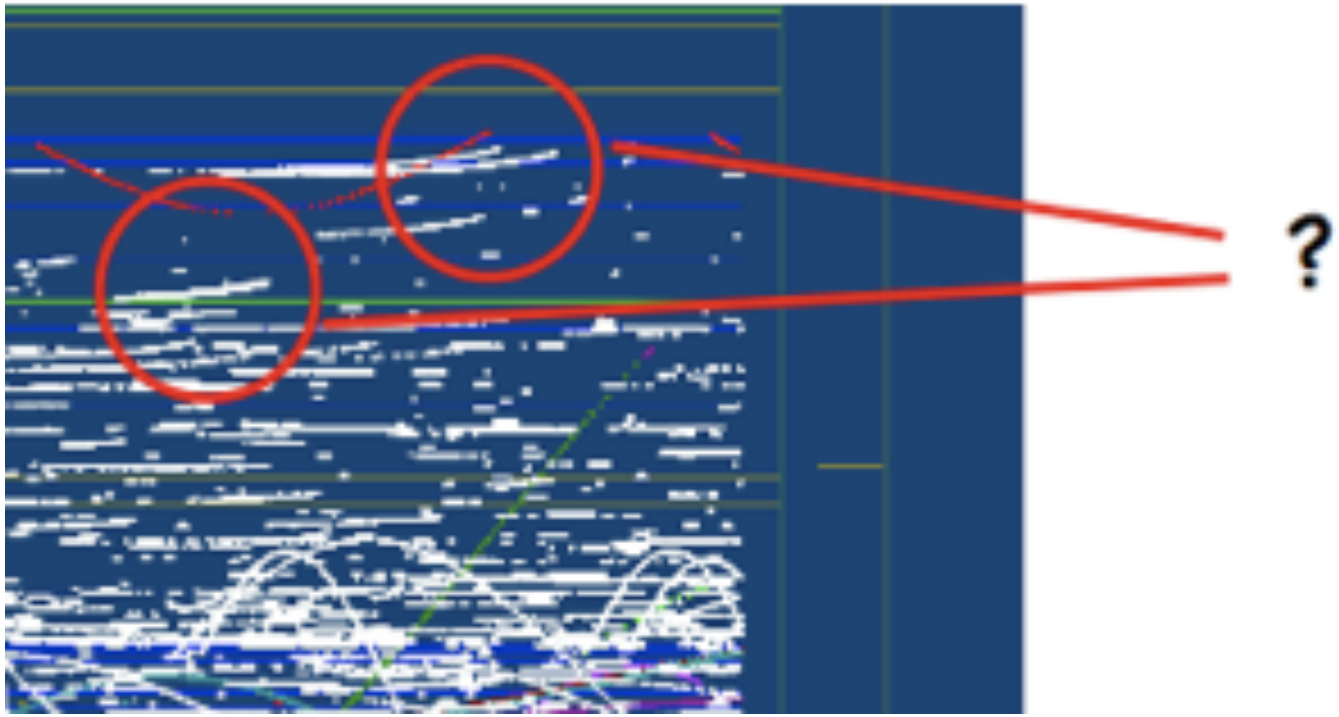
# Background

To determine performance in terms of efficiency
it is vital to determine the denominator correctly

# Mokka

- For physics studies ILD_00 was used including a 10MeV cut made in the Tracking volume
- The hits were based on a pad-ring structure
- Adrian's studies used a modified TPC simulation, which was built to count occupancy, but didn't provide hits in a convenient form for the Reconstruction
- B-Field problems found in the ILD_00fw model created to study background

# Mokka



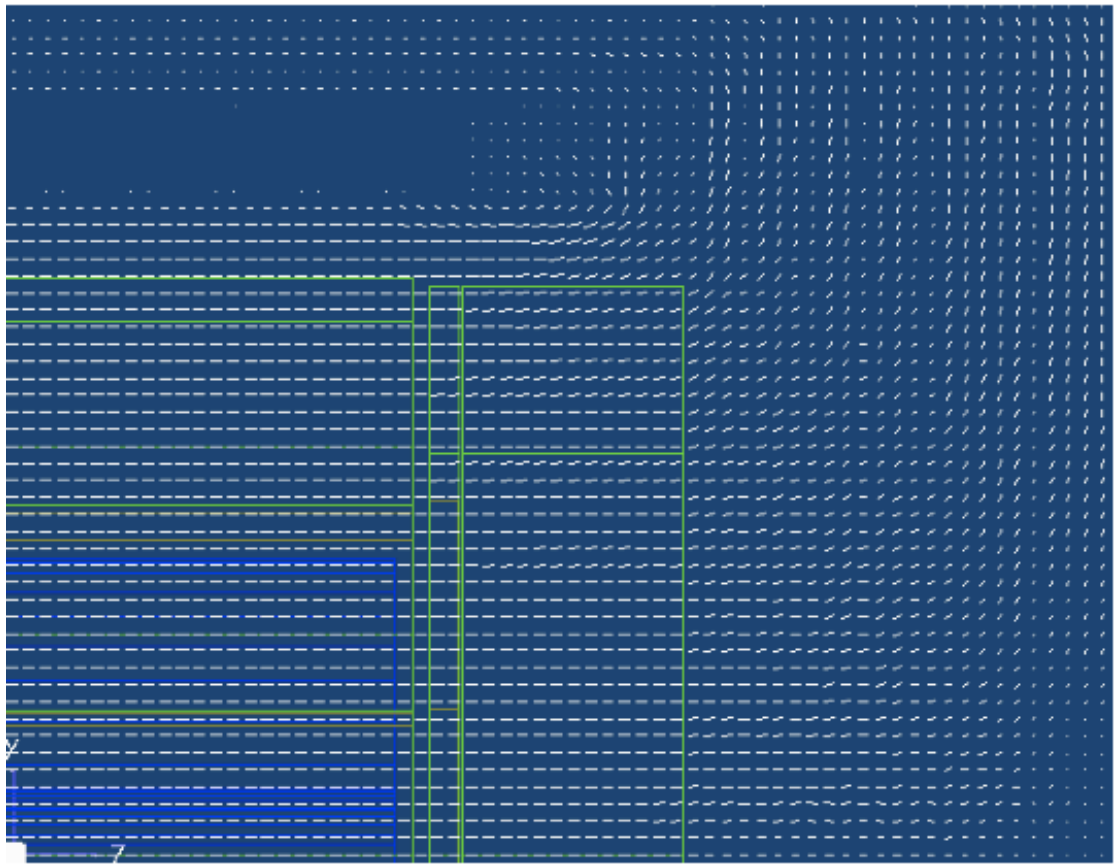

Strange Radial components in the B-Field in the TPC in ILD_00fw

# Mokka

- New Model created ILD_00fwp01
- New non uniform Solenoid with anti-DID
- Much improved treatment of low energy particles pt < 10MeV  in the TPC
  - dedicated step limitation
  - tpcsd03 sensitive detector
- Need to create a new Mokka tag

# Mokka

New non uniform Solenoid field in Mokka which includes the anti-DID



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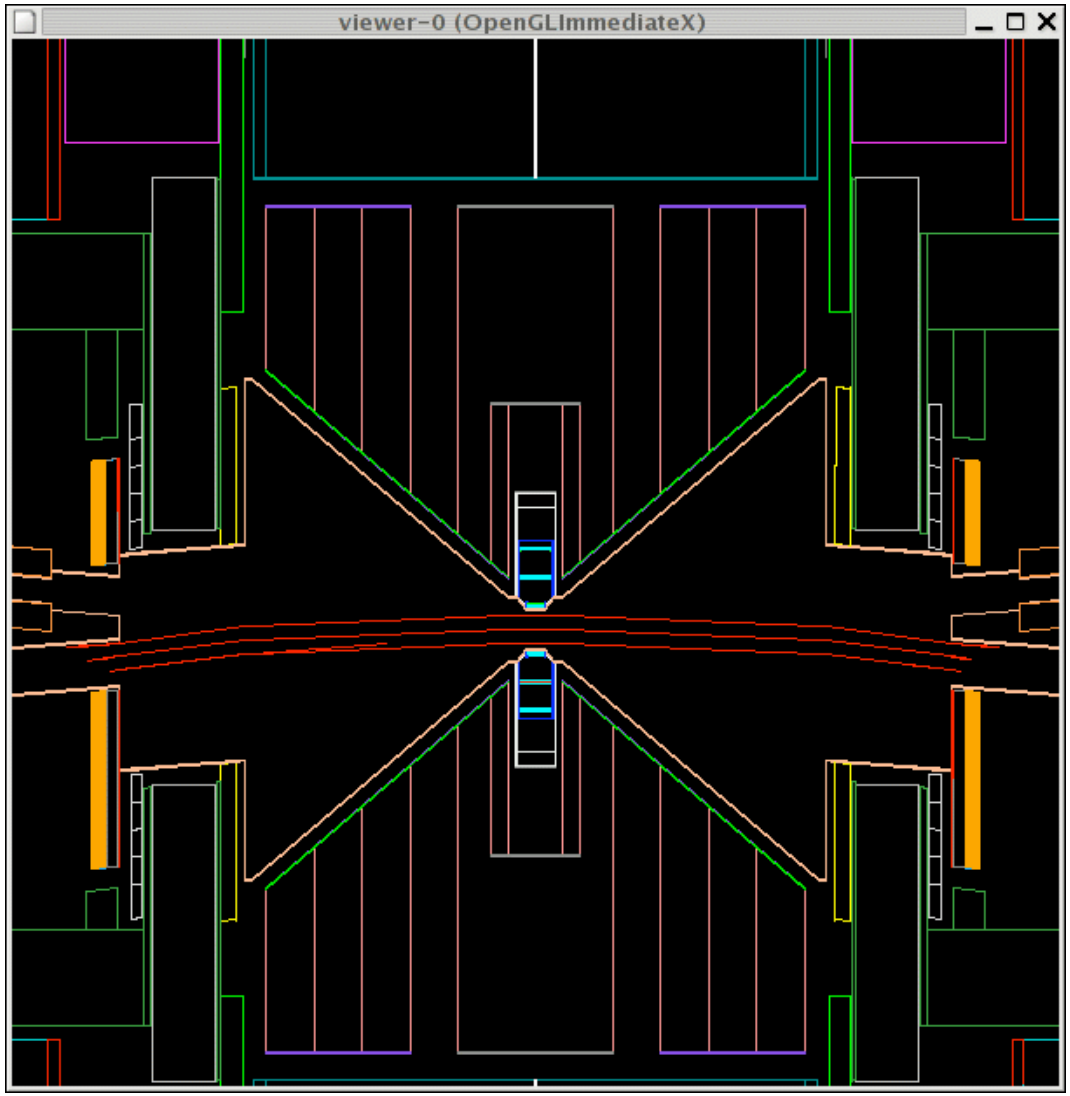
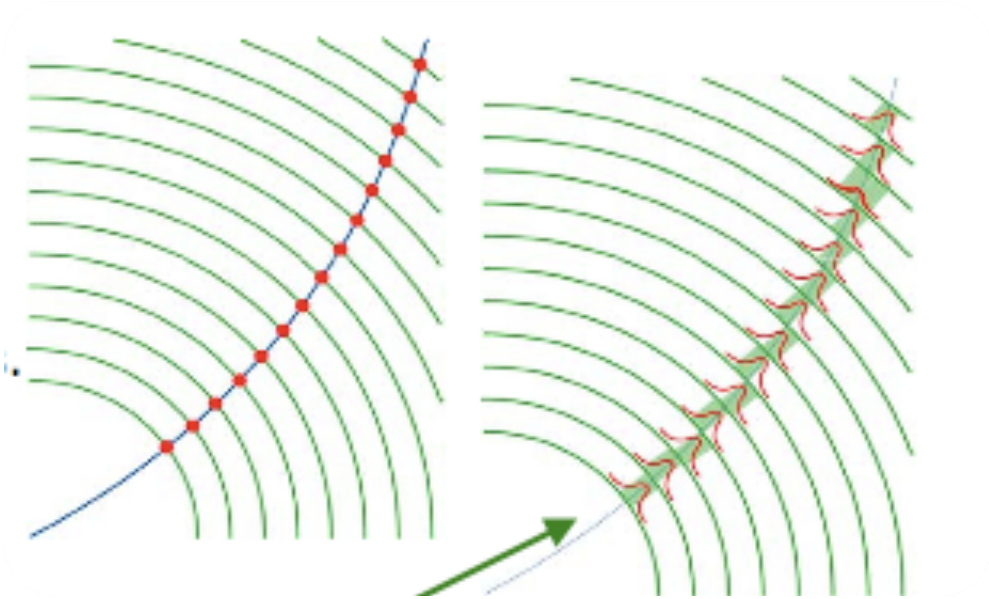



T.Hartin

# Digitisation



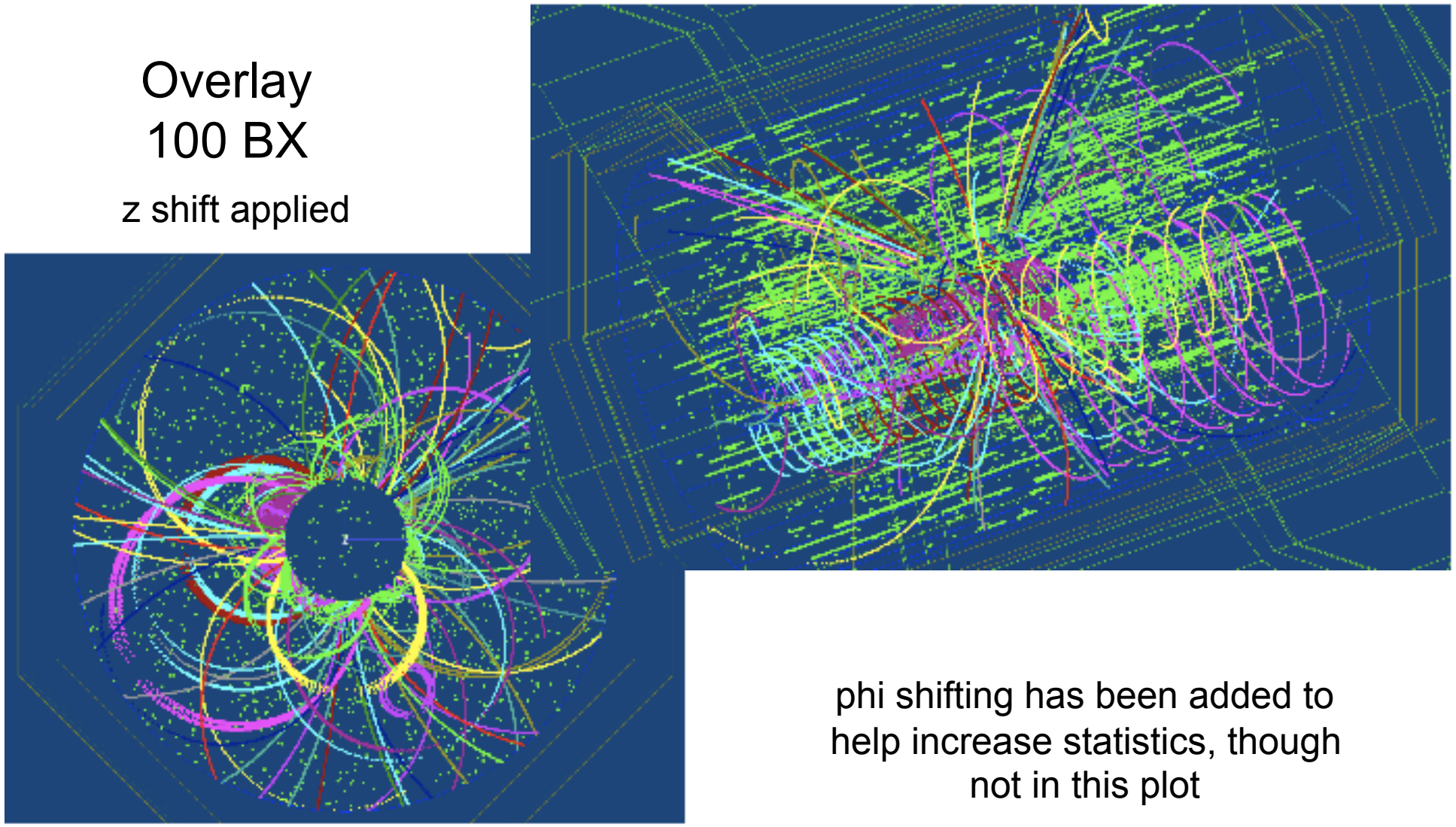
- Mokka provides the space point at which a track cuts the half radii of the pad rows (Left)
- These are then smeared according to the formula below. This is used as a parameterisation of the actual creation of space points from the pad charges (Right)
- This of course is a simplified parameterisation
- Mokka has been adapted to deal with very low momentum particles < 10MeV

| | $\sigma_{r-\phi}/\mu\mathrm{m}$ | $\sigma_z/\mu\mathrm{m}$ | | $\sigma_{r-\phi}/\mu\mathrm{m}$ | $\sigma_z/\mu\mathrm{m}$ |
|---|---|---|---|---|---|
| VTX | 2.8 | 2.8 | FTD | 5.8 | 5.8 |
| SIT/SET | 7.0 | 50.0 | ETD | 7.0 | 7.0 |
| TPC | $\sigma^2_{r\phi} = 50^2 + 900^2 \sin^2\phi + \left((25^2/22) \times (4/B)^2 \sin\theta\right) z\,\mu\mathrm{m}^2$<br>$\sigma^2_z = 40^2 + 8^2 \times z\,\mu\mathrm{m}^2$ | | | | |

# ttbar vs Pairs Background

Overlay
100 BX

z shift applied



phi shifting has been added to help increase statistics, though not in this plot

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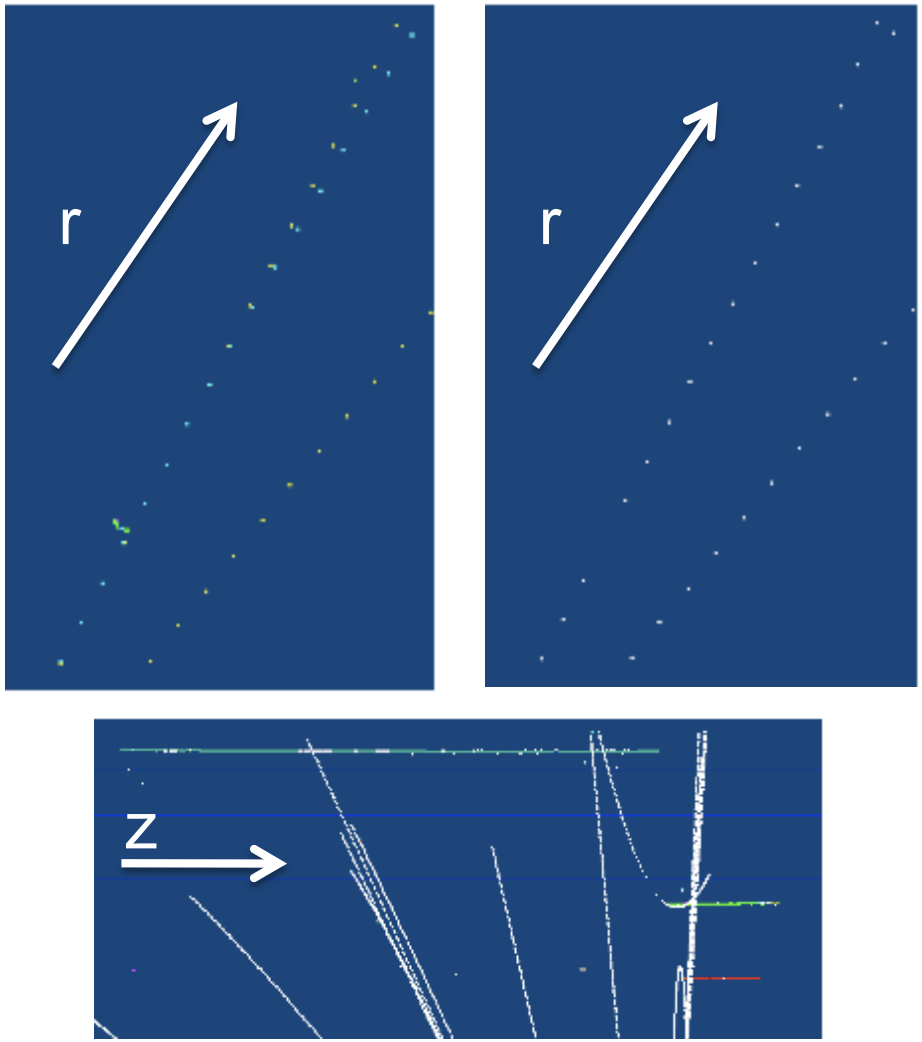
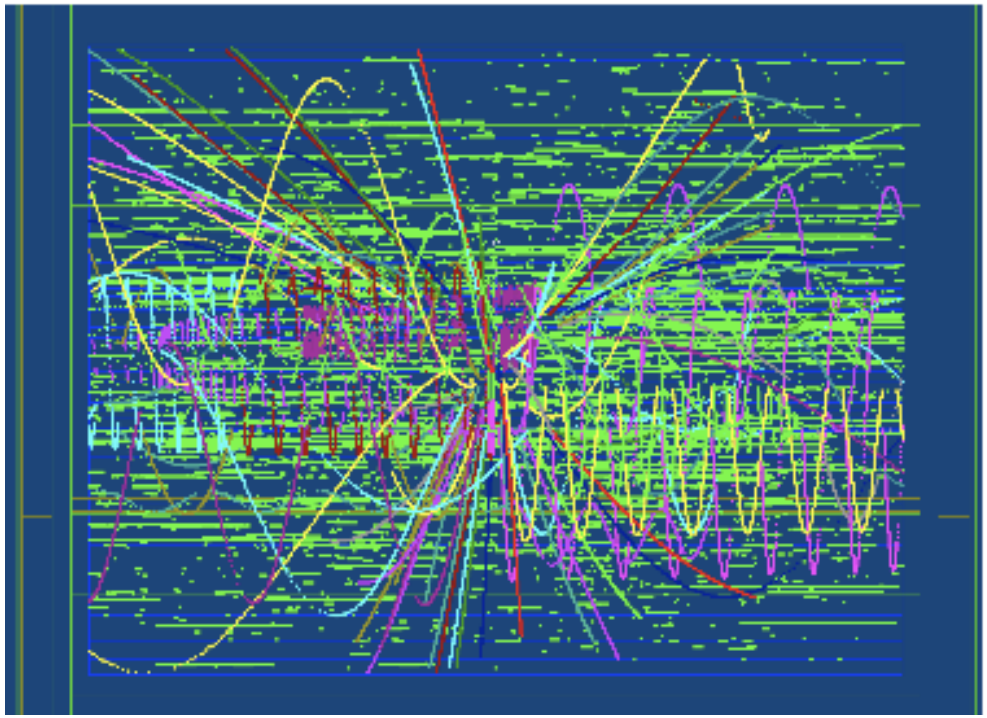



- A search is made within pad rows for hits which are within the given hit separation criteria in rphi and z. These are presently taken from the LoI as 2mm in rphi and 6mm in z, this is where Dan's previous studies are important.
- A nearest neighbour clustering is then performed on these hits
- For small clusters of hits, 3 or less, the hits are merged and there average position taken for the hit
- Larger clusters are taken as being identifiable, and are removed, i.e. not presented to the track finding

# Digitisation – Cleaning



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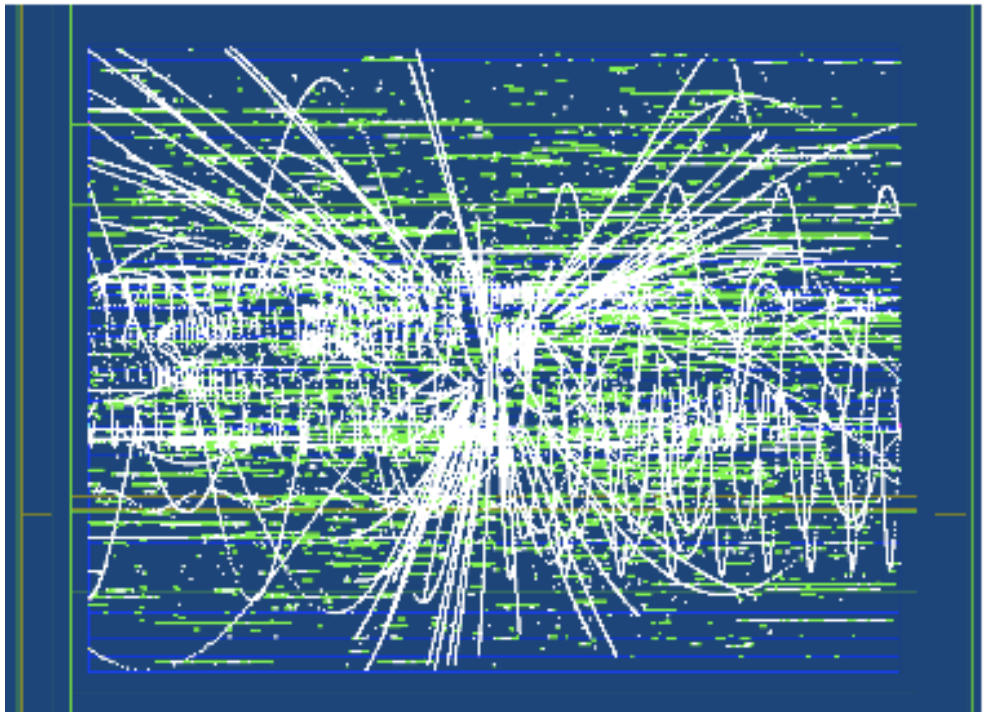

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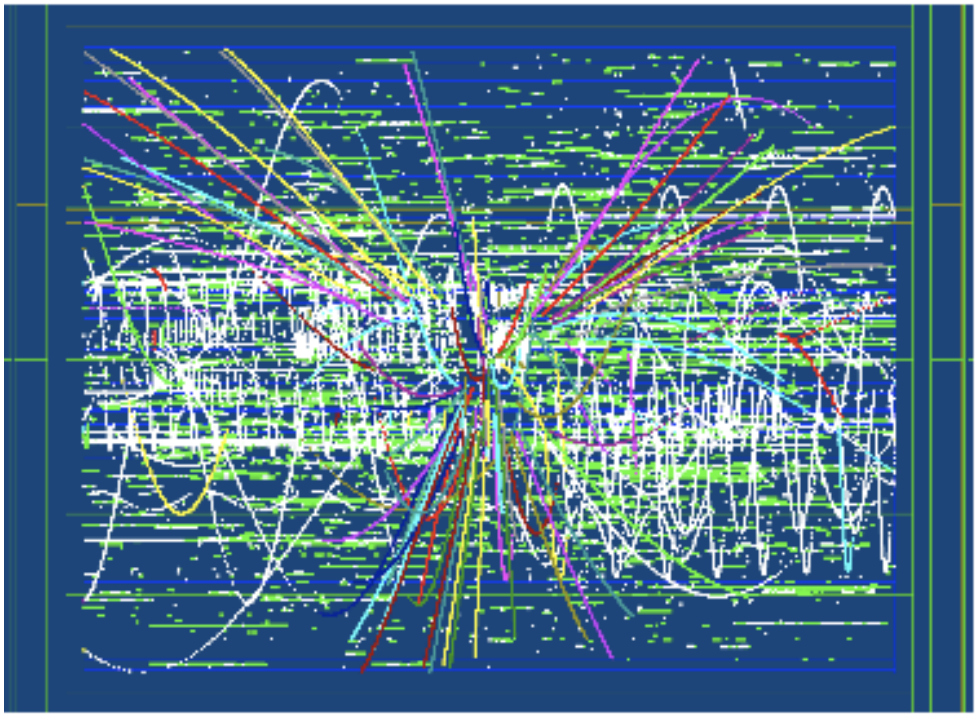

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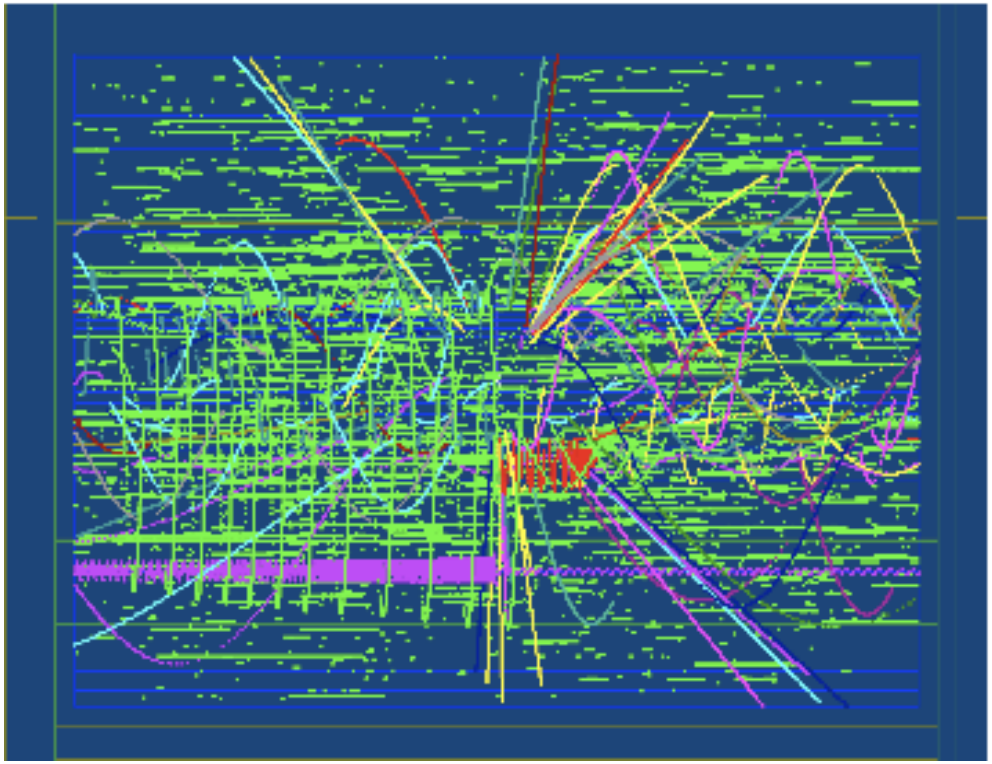
# Preliminary Overlay Sample

100 Bx of pairs background for 500 GeV nominal design using new Mokka and Model



randomisation of phi on event by event basis background hits

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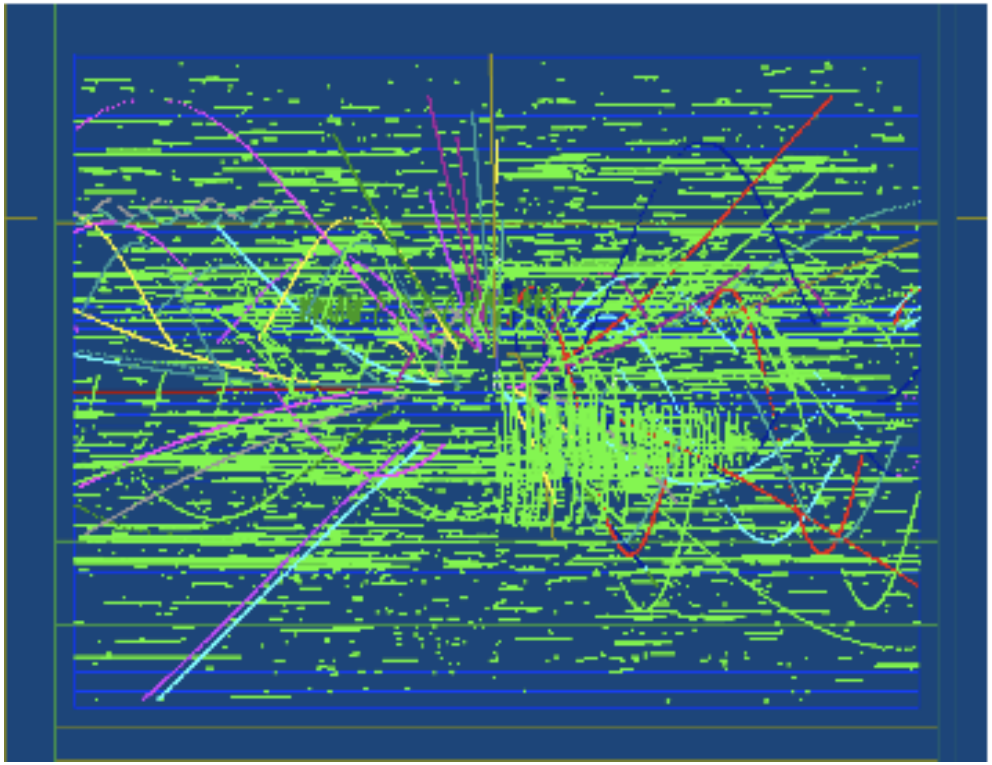

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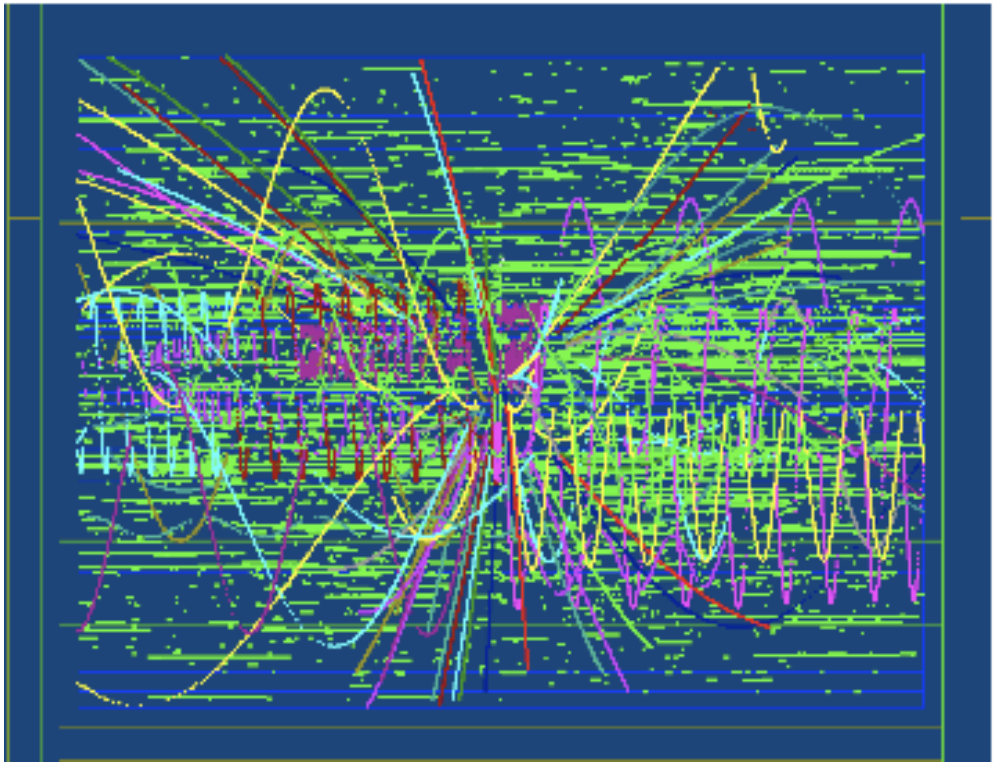

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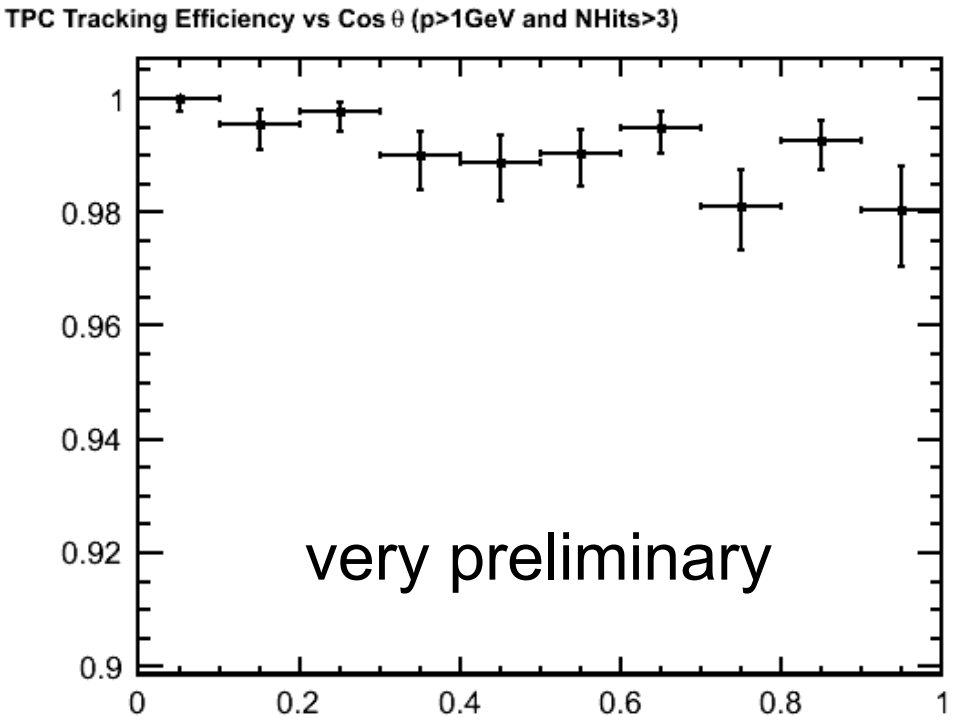
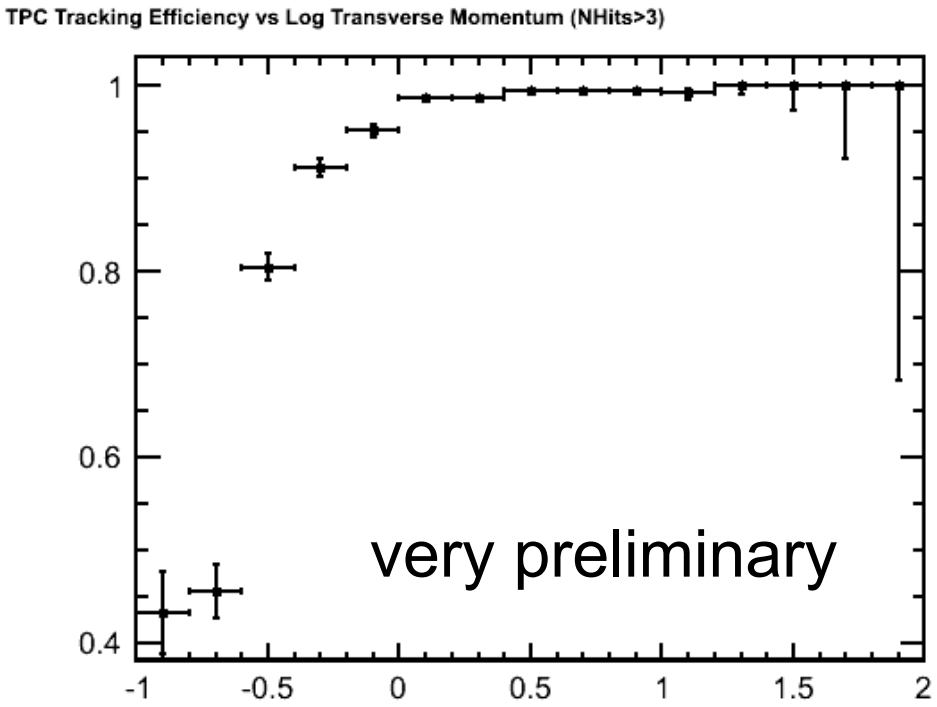
# Very Preliminary Results




100 ttbar events with 100Bx pairs overlay
Using only the same 100Bx but random selection and with correct z and random phi shift

# Plans

- Tag Mokka
- Produce large sample for overlay
- Carefully define denominator for efficiency
- Overlay 10, 100, 150, (200?) Bx of pairs background