Status report on L1 Tau Trigger with pixels for Phase 2

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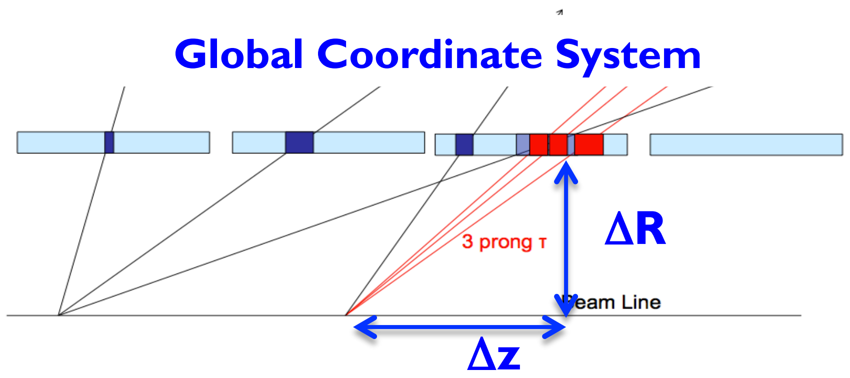
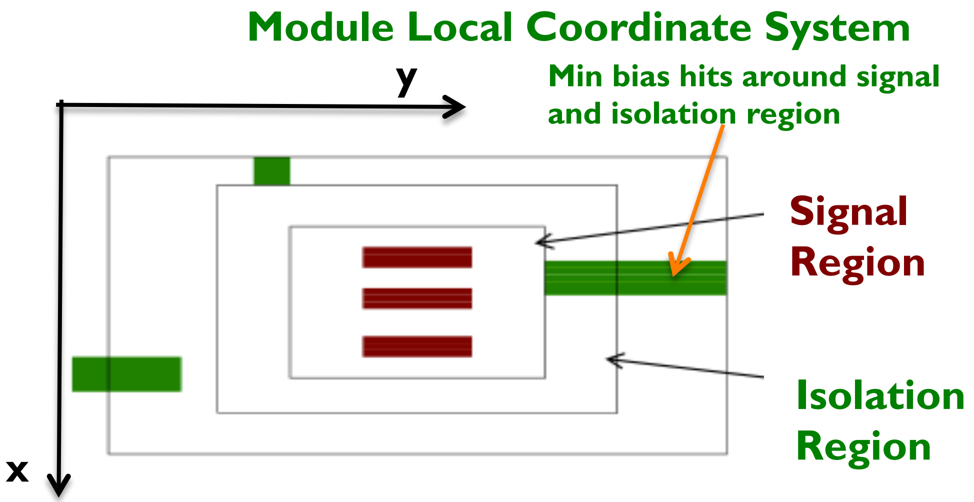
Introduction

- Ongoing study of possible Tau Pixel Trigger at L1 for a τ decaying into 3 prongs was presented on:
  - Preliminary results on TTI Meeting 6th May: https://indico.cern.ch/getFile.py/access?contribId=3&resId=0&materialId=slides&confId=250641
  - During the Upgrade Week in Desy: https://indico.cern.ch/getFile.py/access?contribId=8&resId=0&materialId=slides&confId=254097
- τ to 3 prongs signal identifiable as an isolated triplet of clusters with similar size

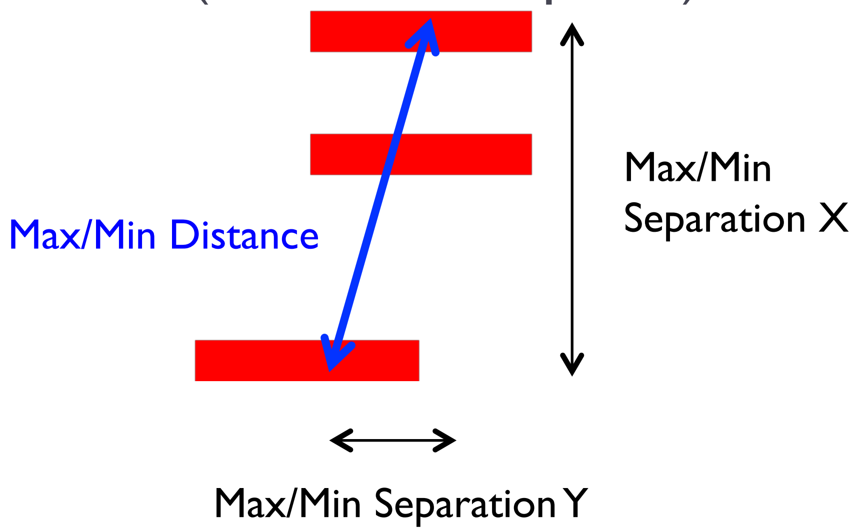


Δz = cluster_barycenter - τ_z_production_Vertex



Single Module Standalone algorithm

- Signal Phase Space optimized for chosen visible τ P_T (40, 60 or 80 GeV) depending on layer in Pixel Barrel detector:
  - Cluster Size along local X ≤ 3
  - Cluster Size along local Y cut depending on module z position (from 8 to 12 pixels)
  - Charge per pixel between 6500 and 23500
  - Min/max separation
  - Max distance
  - Similarity on Size X and Size Y (max ΔSize ≤ 1)



- Isolation Region :
  - Calculated to keep 80% of τ signal in PU environment
  - Requiring no clusters with similar size inside isolation and signal regions

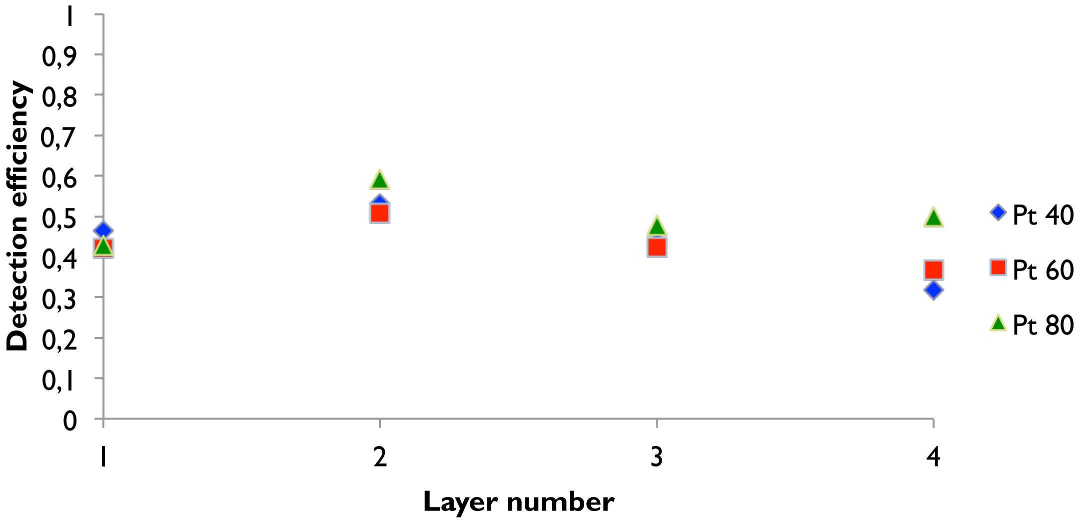
Tau detection Efficiency and Algorithmic Efficiency for different Signal Phase Spaces

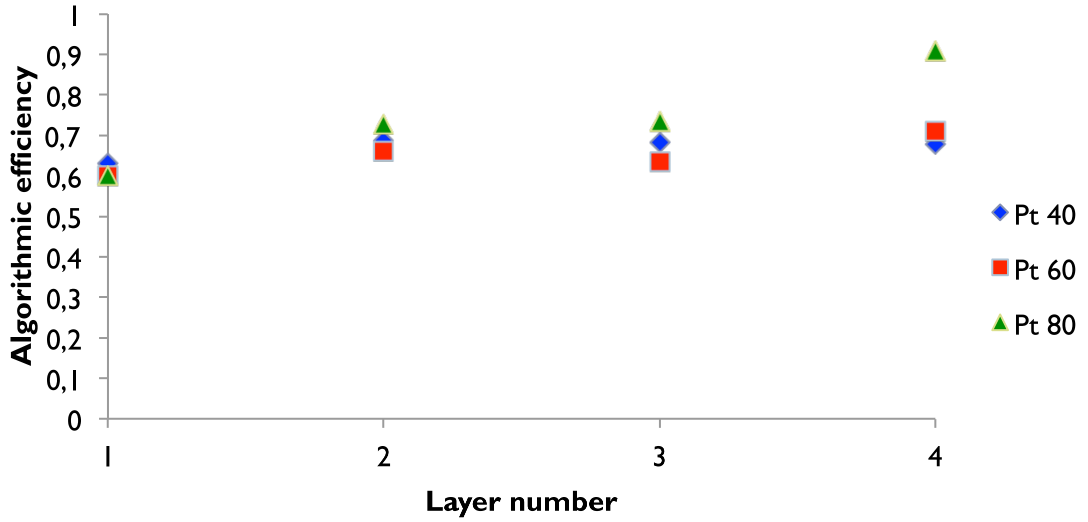
- Required minimum P_T of the 3 Prongs > 2 GeV

Tau Detection Efficiency=N t → 3 prongs for which ∃ associated selected triplet in the given layer/N of t → 3 prongs decayed within the layer acceptance

N Algorithmic visible t=N of t → 3 prongs decayed in a single module in three different clusters within the layer acceptance

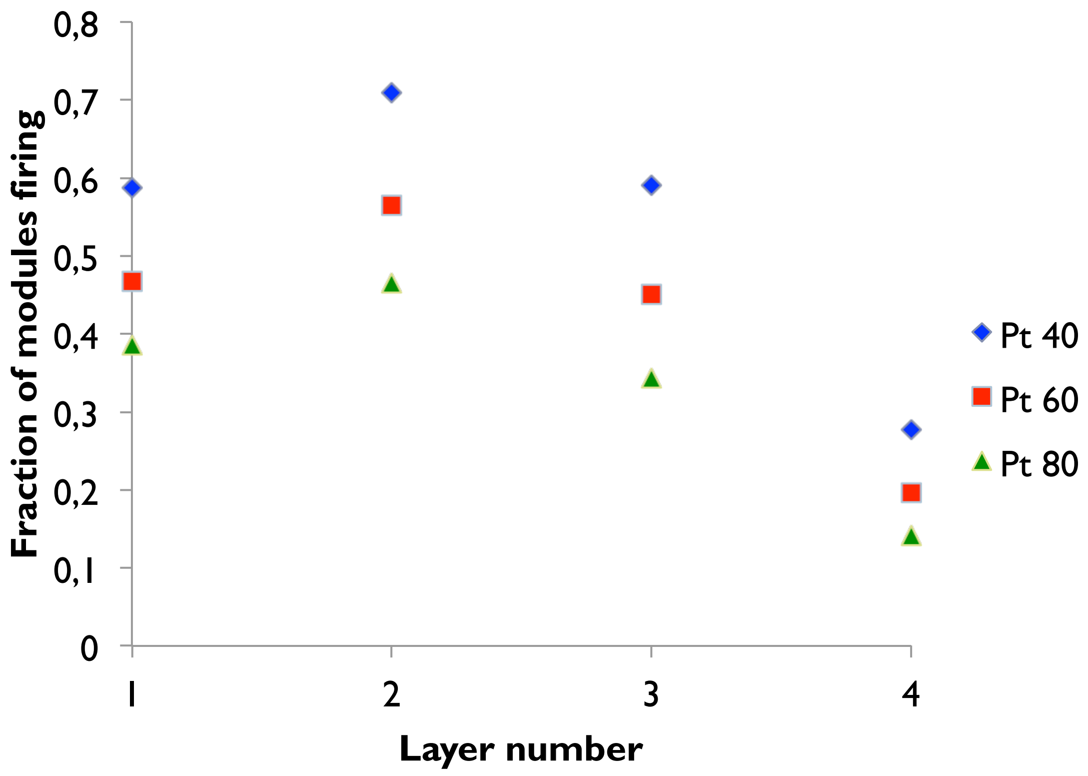
Algorithmic Efficiency=N Algorithic visible t for which ∃ associated selected triplet in the given layer /N Algorithic visible t

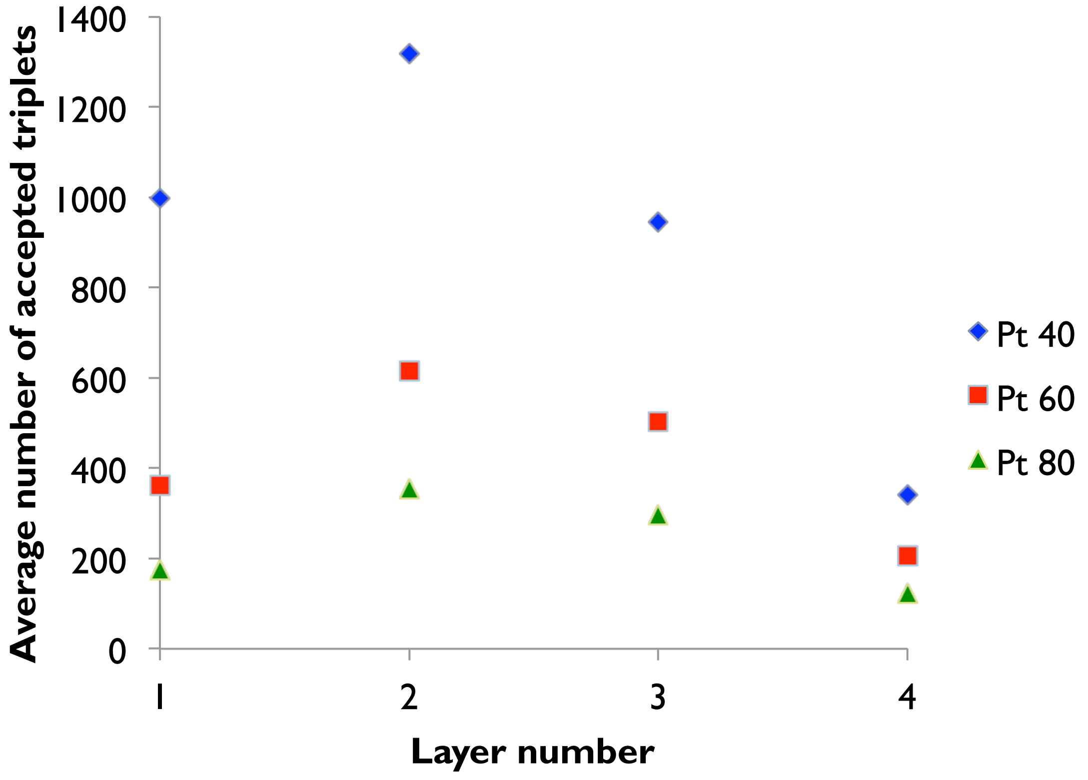




Tau with 140 PU

Algorithm performance on MinBias events with 140 PU

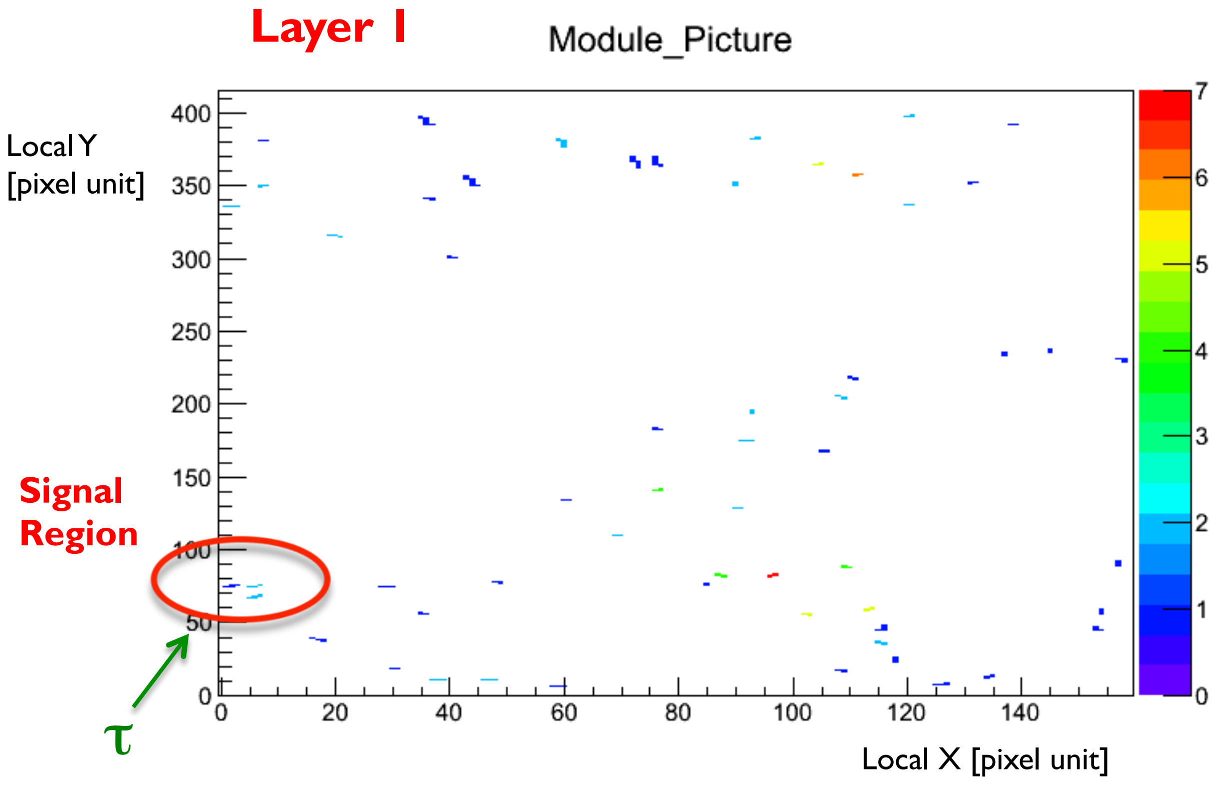


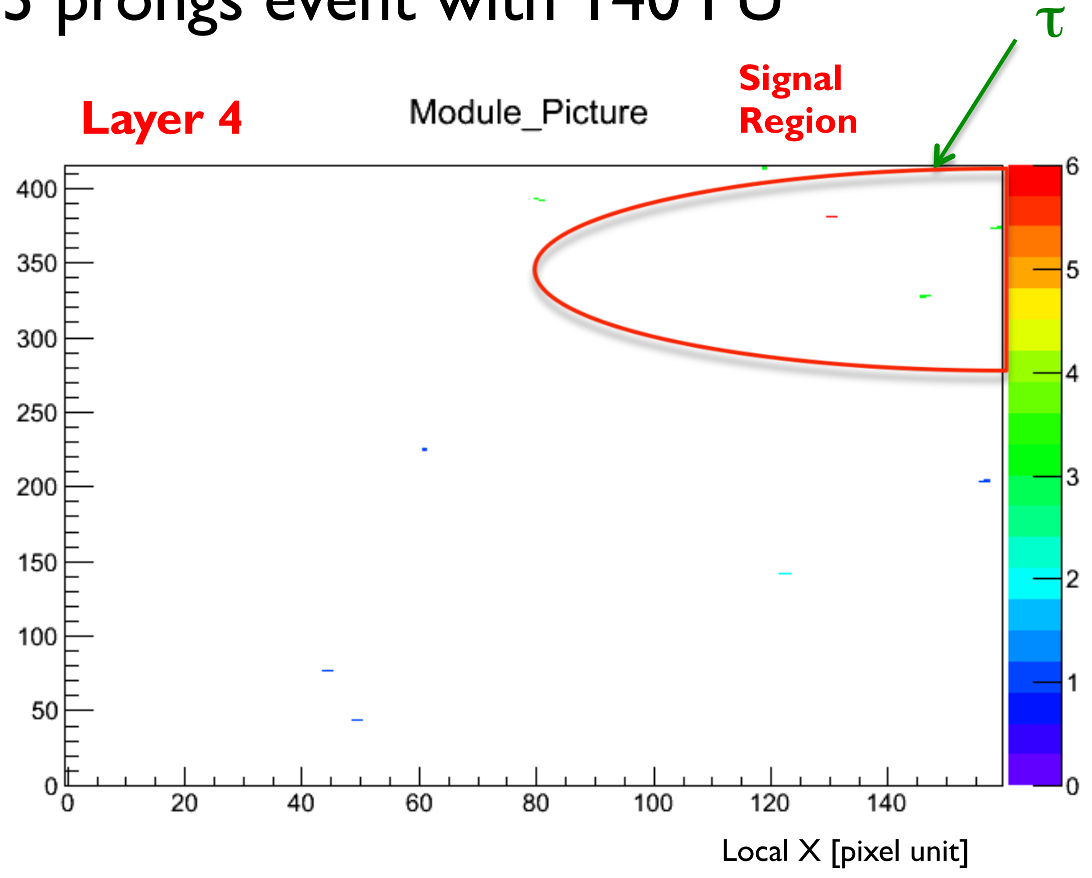


- *Present Signal Phase Space parameters do not allow to distinguish between signal coming from τ and signal coming from MinBias events using single layer information*

Example of triplet population inside one module

- Accepted triplets in one Module for $\tau \rightarrow 3$ prongs event with 140 PU

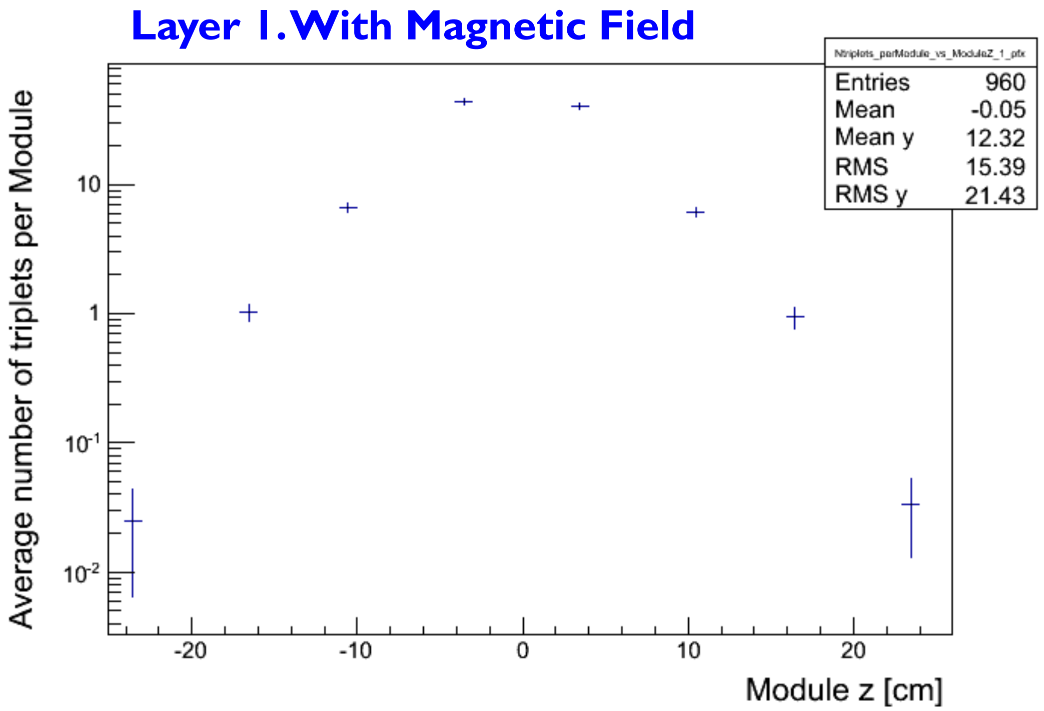


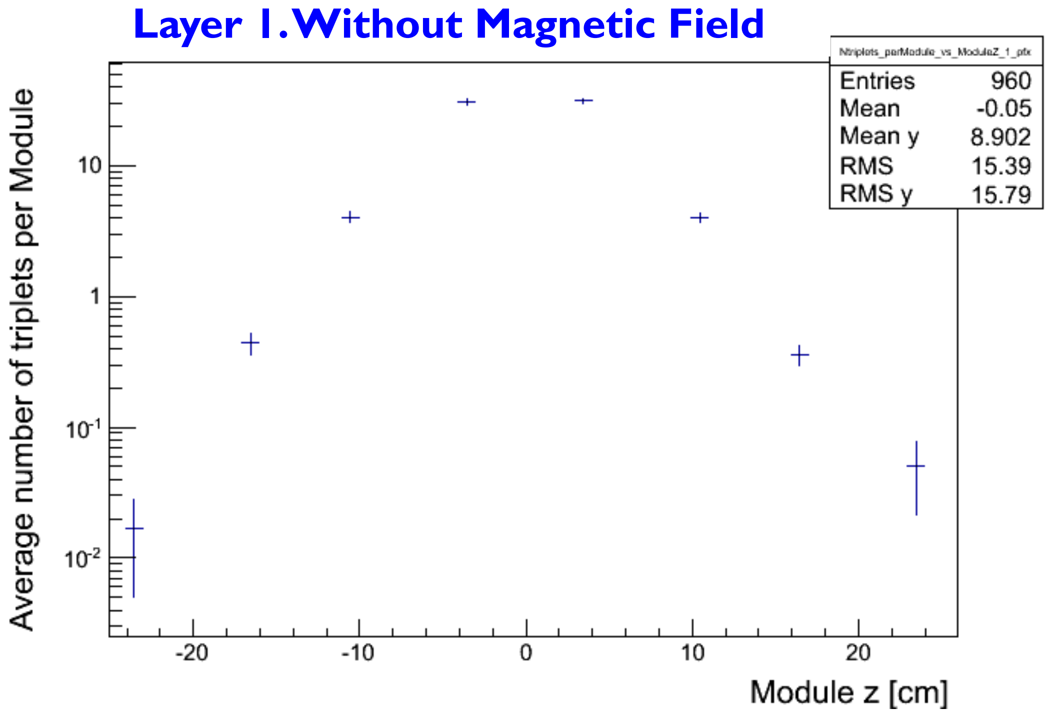


Visible P_T of τ ~ 78 GeV – 40 GeV Signal Phase Space parameters

Study the source of Fake triplets in MinBias events

- Generated 10 Minimum Bias events with 140 PU, keeping Tracking Particle and Tracking Vertex information to access the MC truth
  - Samples made with standard condition and without Magnetic Field to study contribution from loopers (see F. Palla's presentation on June 6th - Upgrade Week Desy)
- Distribution of Number of triplets per Module vs Module z position:

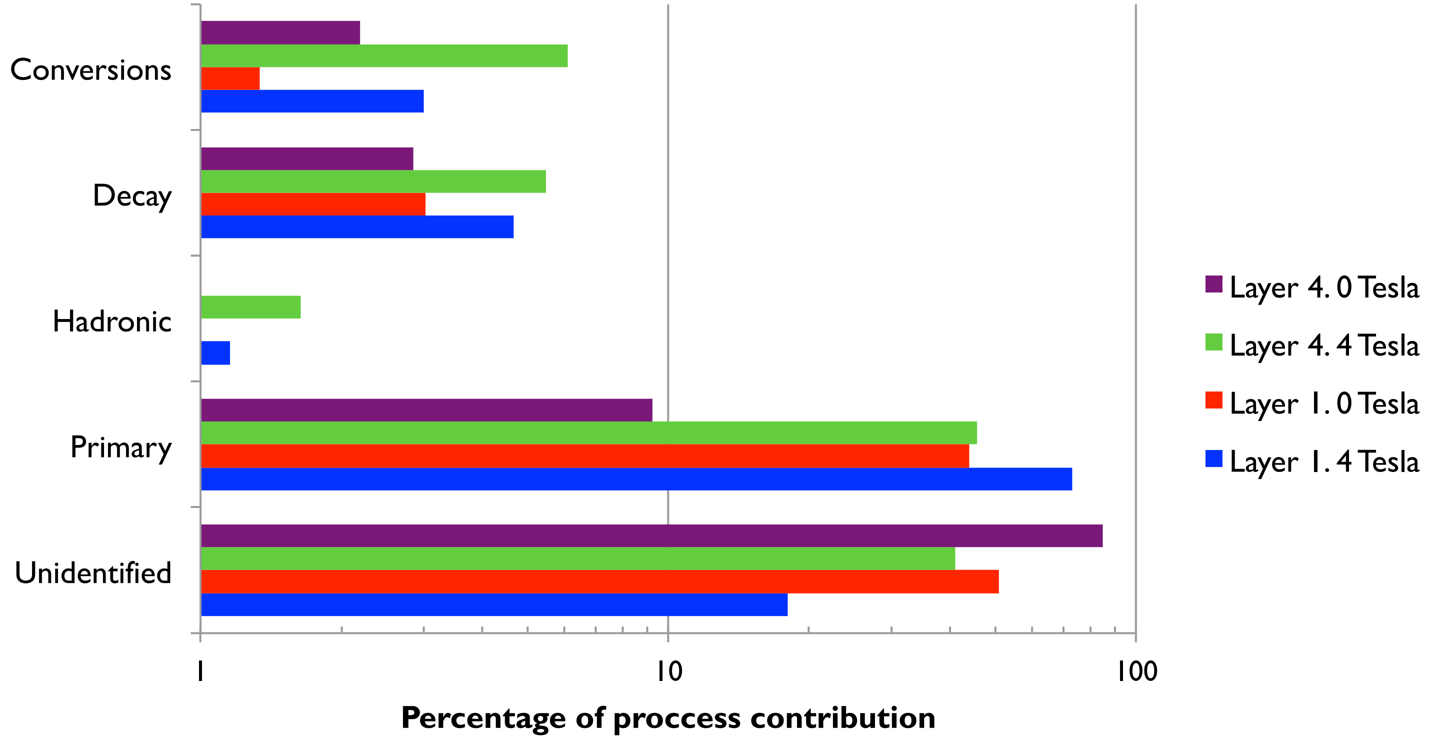




- Algorithm accepts more fake triplets in the central region which is highly populated by clusters with small size along beam line

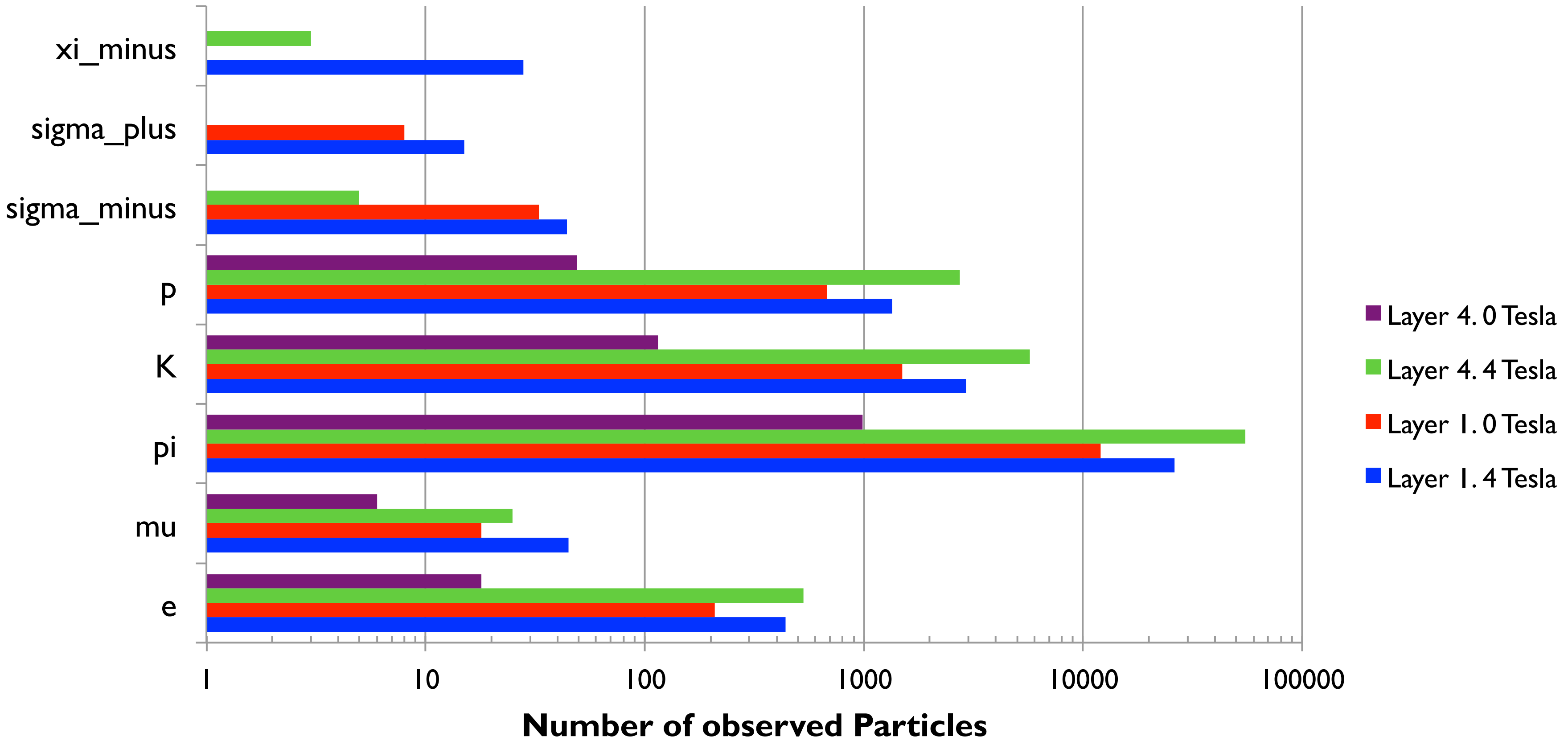
Process Type of contributing tracks

- The main source of Fake triplets comes from Primary tracks
- There is also a huge contribution from unidentified processes, due to the fact that a significant amount of clusters does not have associated tracking Particles

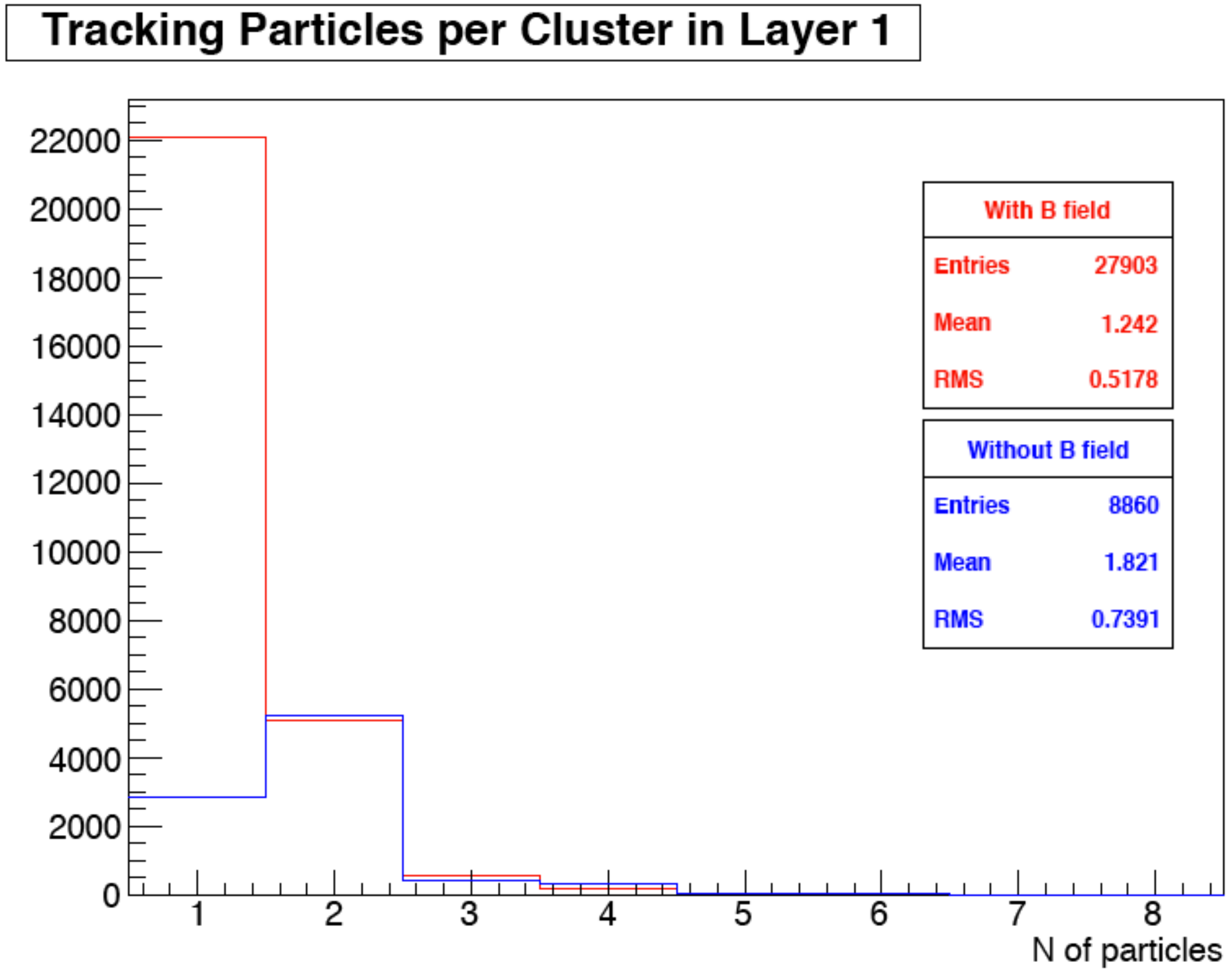


Tracking particles from primary processes

- Among the clusters produced by Primary Process, main contribution is due to π

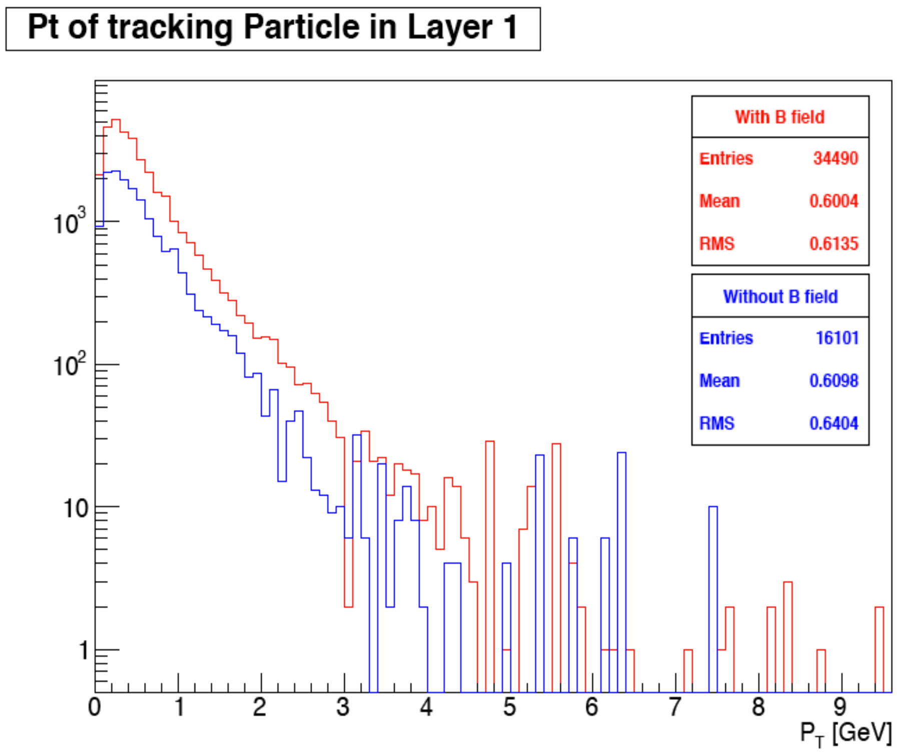


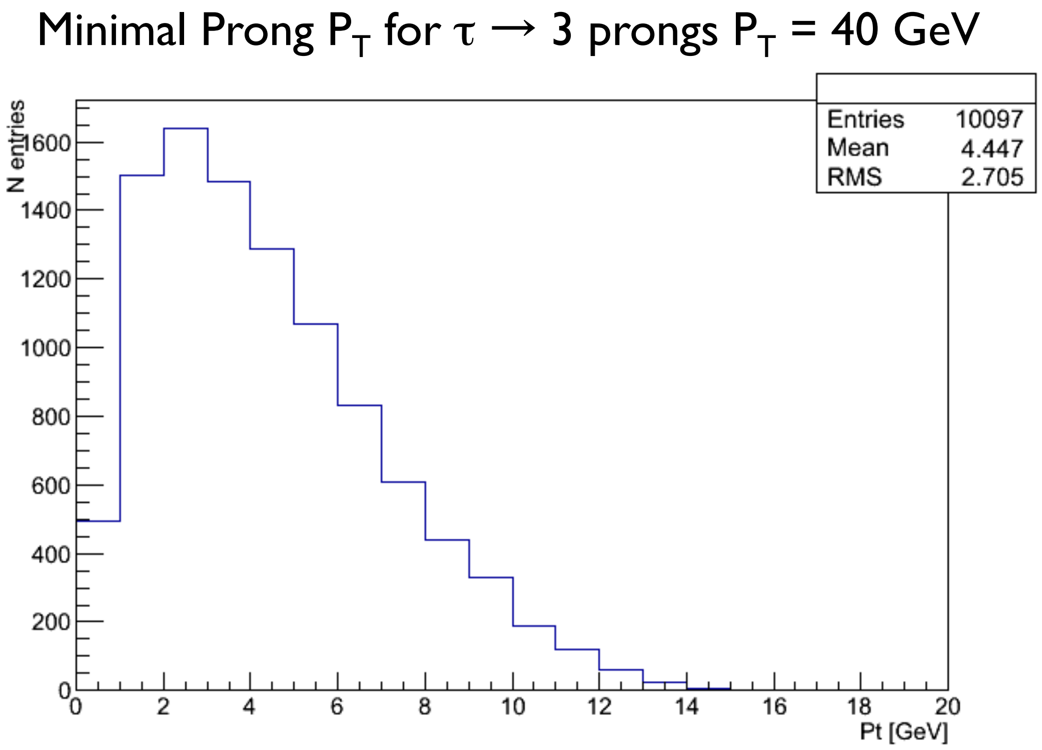
Number of Tracking particles in one cluster



- Low statistics for 0 Tesla sample is due to the higher amount of unassociated clusters on it.
- Without magnetic field applied, there are more merged clusters from different particles

P_T of tracking particles

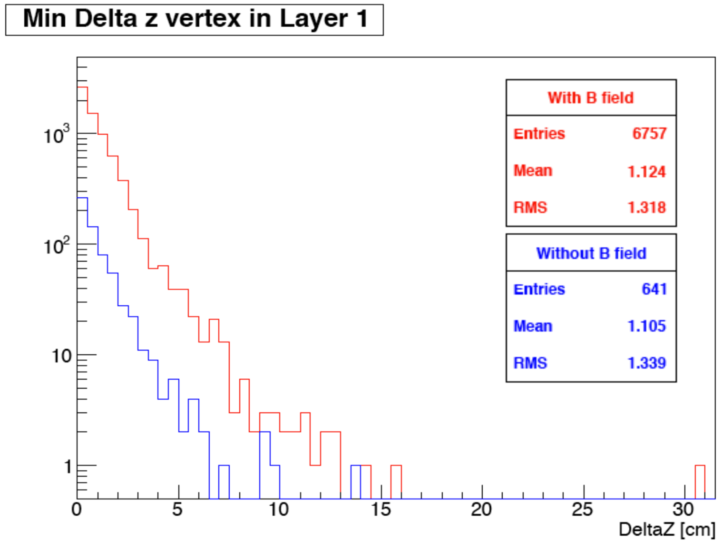


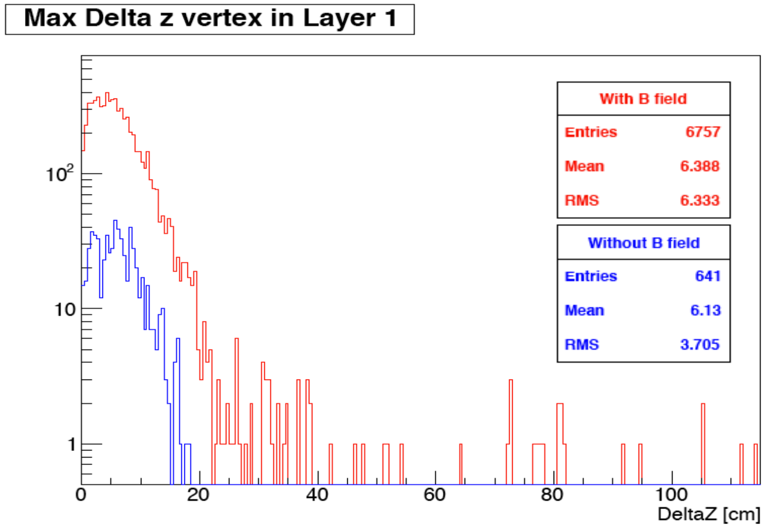


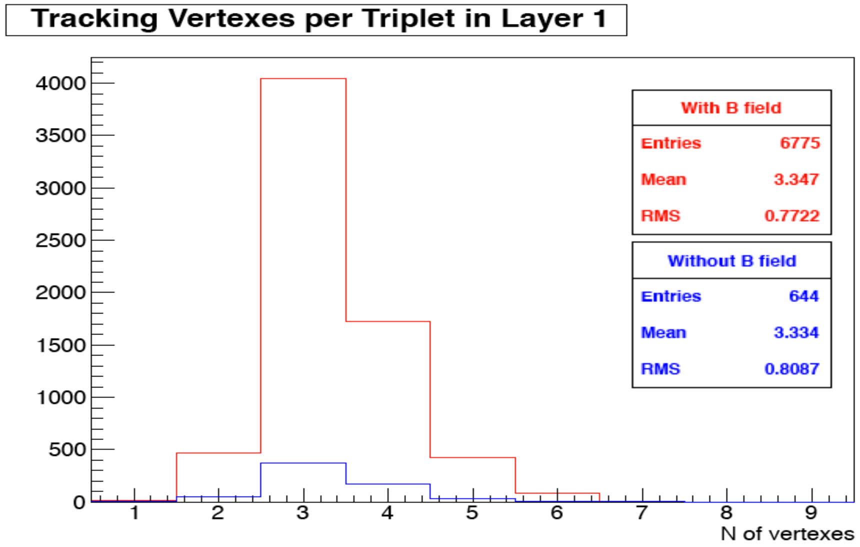
- 97% of tracking particles has P_T less than 2 GeV
- There could be a possibility to reject these low P_T tracks matching triplets in different layers

Tracking Vertex information

- Requiring that all clusters inside the triplet has tracking particle associated and that there are at least 3 contributing tracking particles inside the triplet







- Most of tracking particles in one triplet come from different vertexes, therefore we expect that there should be no correlation between them.
- This fact tells us that primary origin of fakes can be due to random coincidences produced in high occupancy environment

Conclusions and plans

- Preliminary study of MinBias background shows that majority of fake triplets are produced by uncorrelated π from low P_T primary processes.
  - We should try to use merged SimTracks to have a complete MC truth match for all the clusters to understand their source.
- Huge amount of accepted triplets in MinBias event does not allows to have standalone tau trigger in a single Pixel module
- Study the possibility to match triplets in different Pixel layers to reduce MinBias background