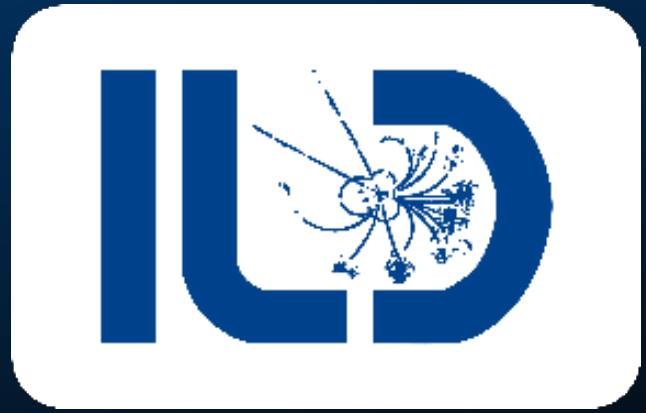
# Report on Track Recovery and Particle ID using dEdx

A. Irles, LAL-IN2P3/CNRS

ILD sw/ana meeting, 30th January 2019

**Heavy Flavour Working Group**

S. Amjad (UCL), A. Irles (LAL), R. Pöschl (LAL), F. Richard (LAL), Y. Okugawa (Tohoku U.), R. Yonamine (Tohoku U.)



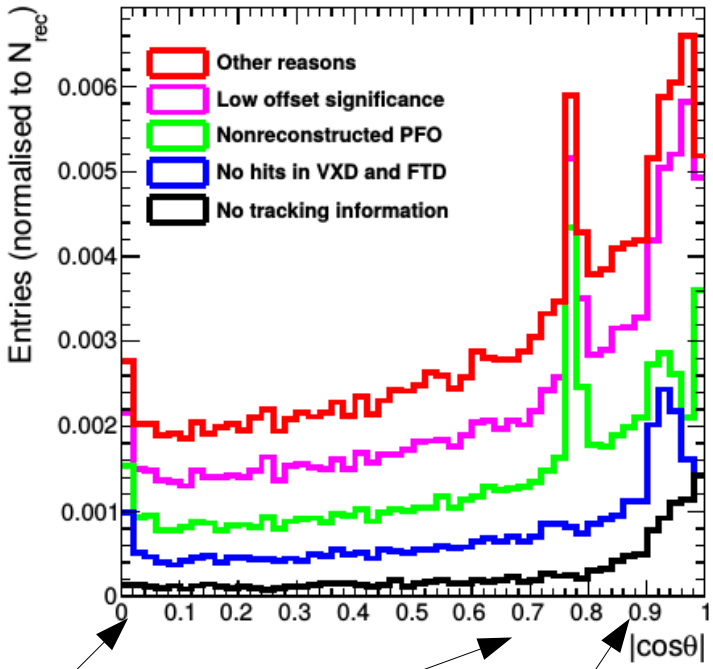
# Today

- Revisiting the Vertex/Track recovery.

- More input on kaon identification using dEdx

# Track/Vertex Recovery (S.Bilokin PhD)

- **S.B. ttbar (500GeV, DBD). Lost tracks and recovered tracks.**




TPC plate (+ calo cracks ?)

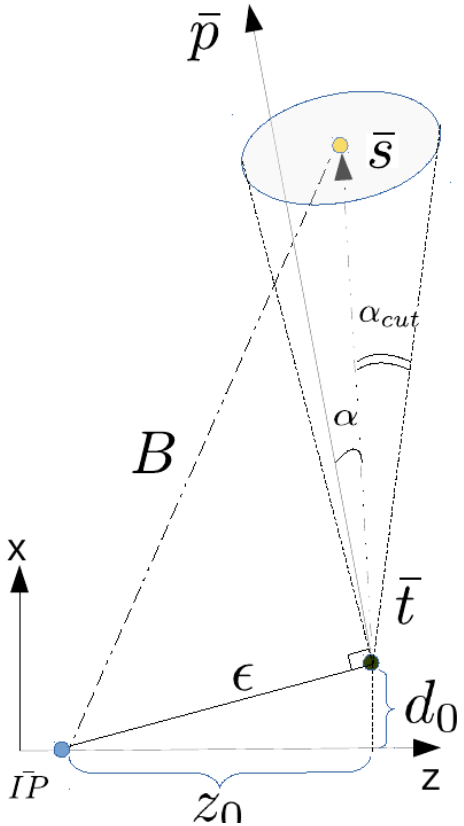
Transition between calo barrel and endcaps

End of acceptance of VXD

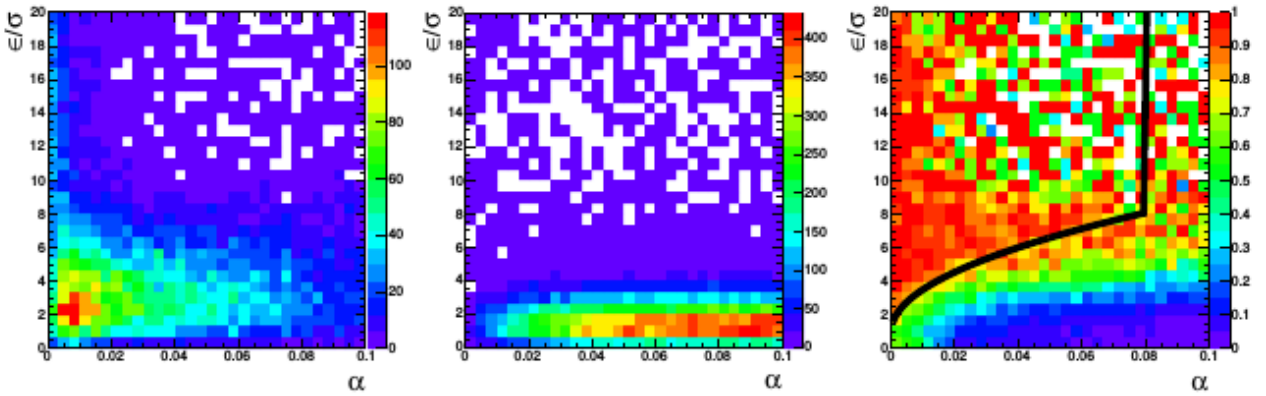
- No tracking information - the MarlinTrk algorithms fails to reconstruct the track. This category is tiny - only 0.93% of the generated prongs;
- No associated hits in the VXD or FTD - the track segment from the Vertex Detector or Forward Tracking Disks was not connected to the long TPC track segment. These reconstructed particles have large uncertainties on the impact parameters, which makes them not suitable for vertexing algorithms. They constitute 2.% of the generated prongs;
- No reconstructed PFO - the PandoraPFA fails to create the PFO from a reconstructed track. These tracks are discarded by the LCFI+ algorithms - 3.2% of the generated prongs;
- Low generated momentum or offset - the reconstructed particle was produced with impact parameters below the detector resolution - 3.1% of the generated prongs;
- Other reasons connected to vertex fitting problems - 1.7% of the generated prongs.

# Track/Vertex Recovery (Reminder S.B)

- **ttbar (500GeV, DBD). Variables used to tune the recovery.**



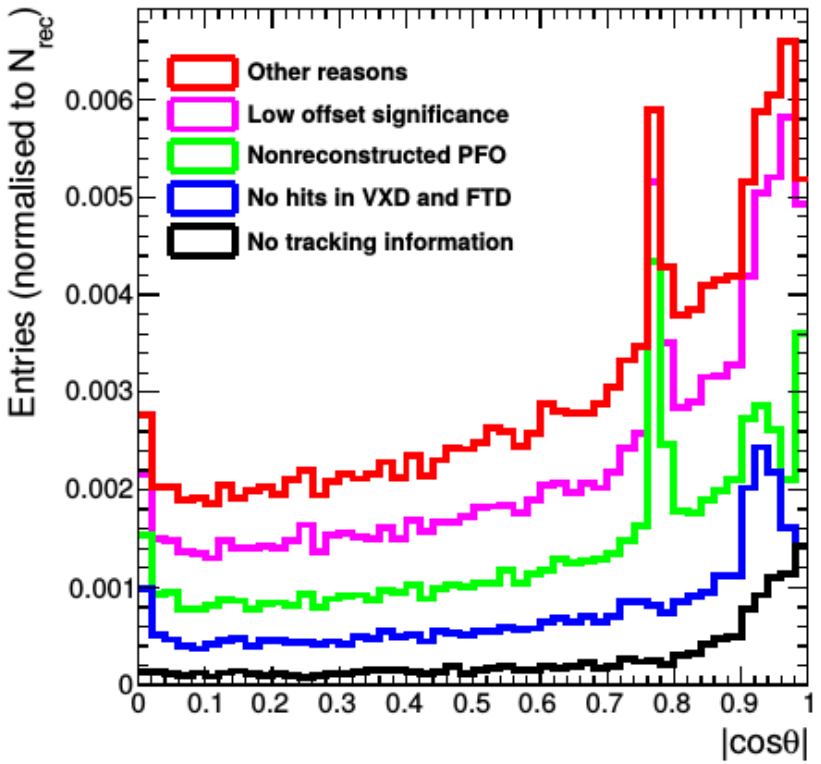

**IP** – interaction point (primary vertex) , **s** – secondary vertex, **t** – point of closest approach of a track, **p** – reconstructed momentum, $\epsilon$ - offset of a track from primary vertex $\epsilon/\sigma = d_0/\sigma_{d_0} + z_0/\sigma_{z_0}$



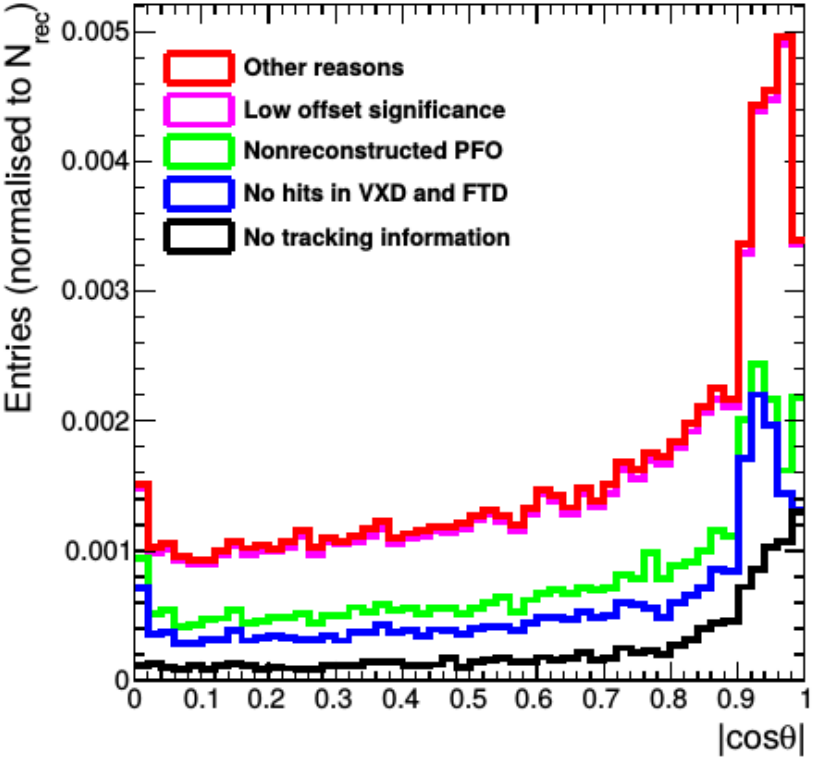

(a) Missing particles (b) Background (c) Purity map

# Track/Vertex Recovery (Reminder S.B)

- **S.B. ttbar (500GeV, DBD). Lost tracks and recovered tracks.**




Recov.



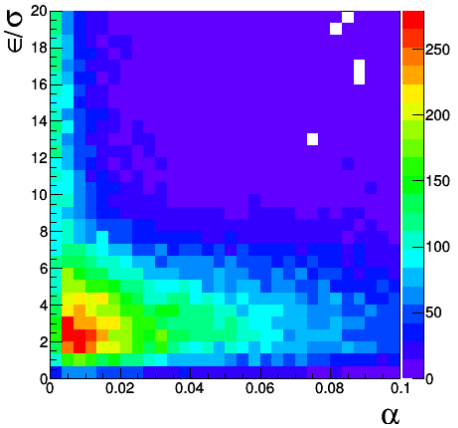
# Track/Vertex Recovery ($b\bar{b}$, 250GeV, left pol. DBD)

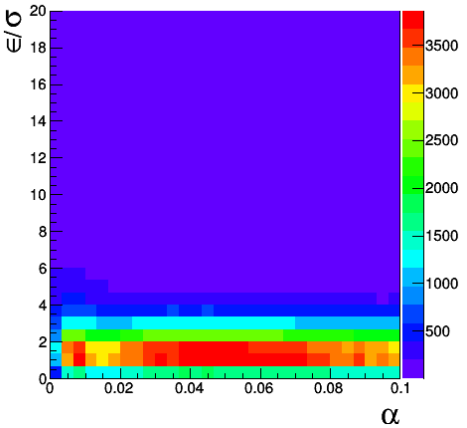
- **Repeat the same with DBD software (ILCSOFT=v01-17-06) and samples**
  - Processors:

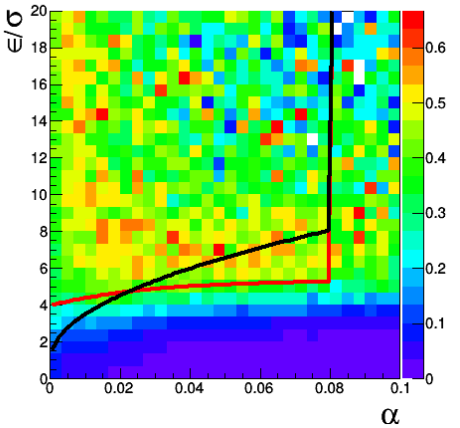
    FastJetProcessor (generalized kT, 2 exclusive jets)
    LcfiplusProcessor (JetVertexRefiner, FlavorTag with qq250_v02_01 files and ReadMVA)
    VertexRestorer and Truth Processors → all in https://github.com/QQbarAnalysis/

# Track/Vertex Recovery ($b\bar{b}$, 250GeV, left pol. DBD)

- **Purity maps to tune the recovery**

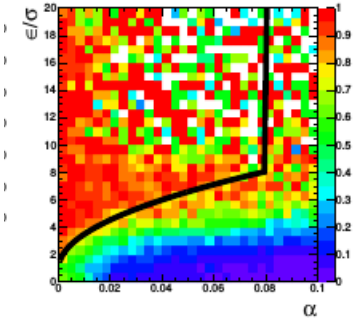


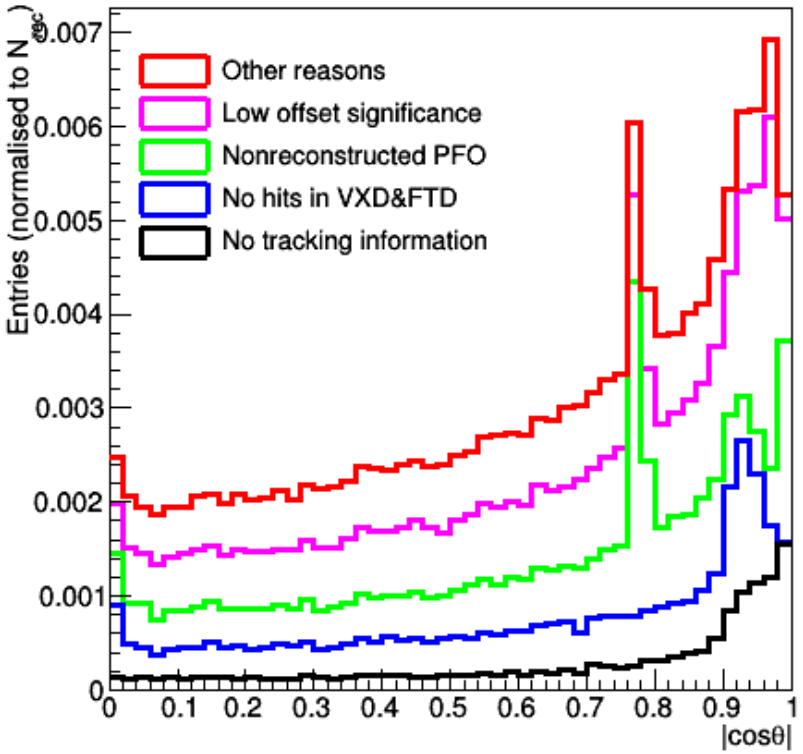




- **Old parametization:**
  - E/sigma > 25sqrt(alpha)+1
- **New parametrization**
  - E/sigma > 4 atan(alpha)+4

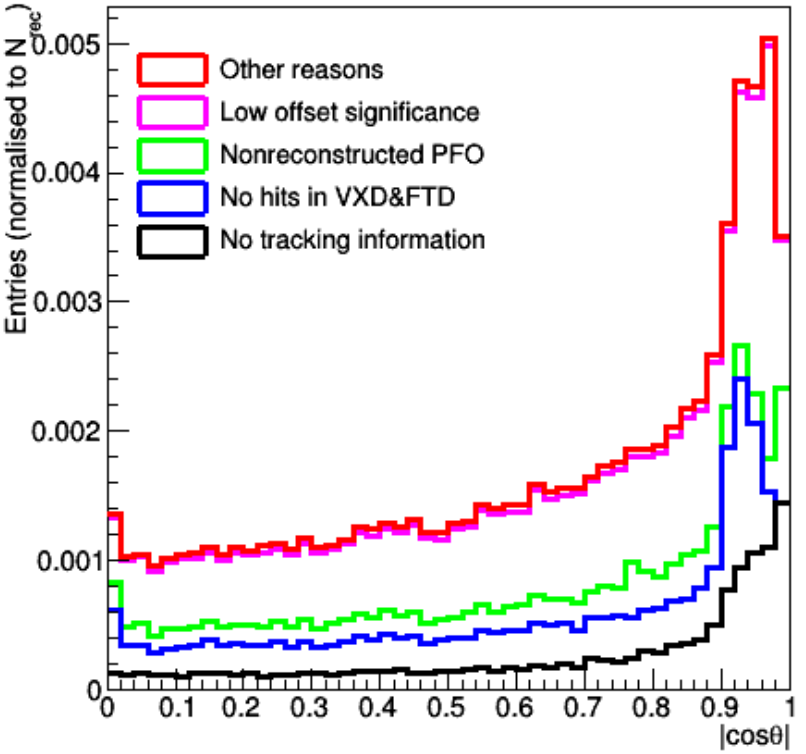
- **ttbar**



# Track/Vertex Recovery ($b\bar{b}$, 250GeV, left pol. DBD)




Recov.



# Track/Vertex DBD vs IDR ($b\bar{b}$, 500GeV, left pol.)

- **DBD software (ILCSOFT=v01-17-06) and samples for 500GeV**
  - Processors:

    FastJetProcessor (generalized kT, 2 exclusive jets)
    LcfiplusProcessor (JetVertexRefiner, FlavorTag with 6q500_v02_01 files and ReadMVA)
    VertexRestorer and Truth Processors → all in https://github.com/QQbarAnalysis/

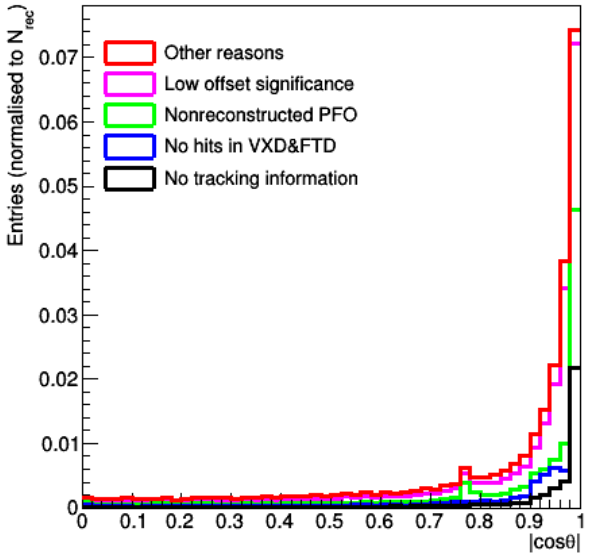
- **IDR software (ILCSOFT=v02-00-02) and samples for 500GeV (large model)**
  - Processors:

    FastJetProcessor (generalized kT, 2 exclusive jets)
    LcfiplusProcessor (JetVertexRefiner, FlavorTag with 6q500_v02_01 files and ReadMVA)
    VertexRestorer and Truth Processors → all in https://github.com/QQbarAnalysis/

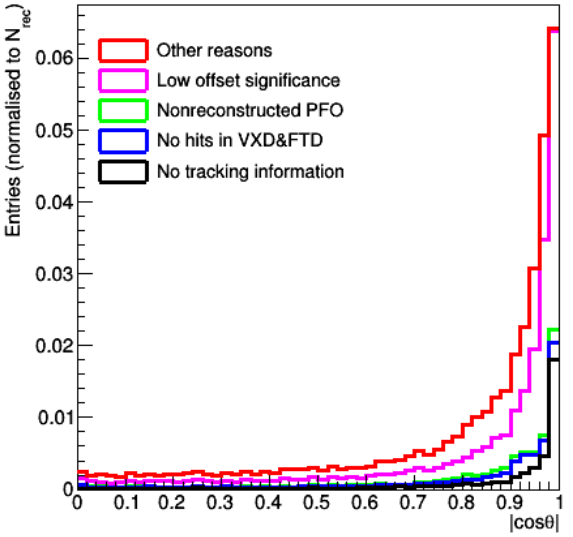
    No vertex reprocessing applied yet in Lcfiplus

# Track/Vertex DBD vs IDR ($b\bar{b}$, 500GeV, left pol.)

- DBD



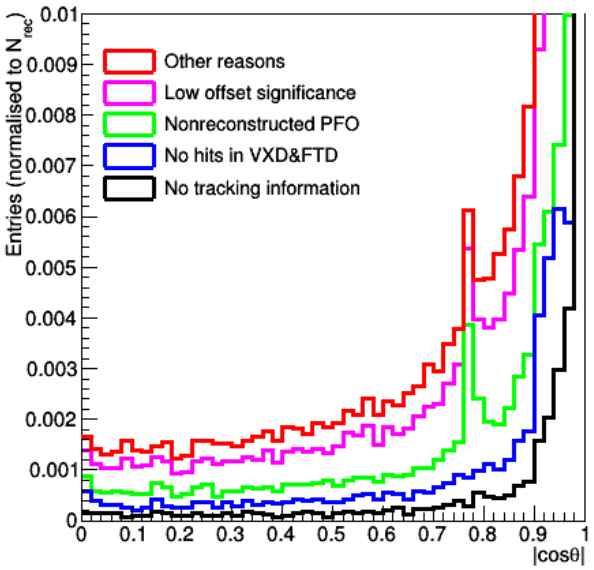

- IDR, large model



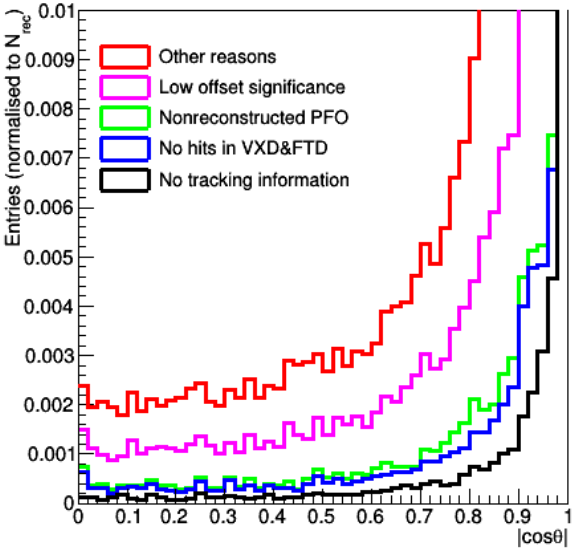

Before Recovery

# Track/Vertex DBD vs IDR ($b\bar{b}$, 500GeV, left pol.)

- DBD




- IDR, large model



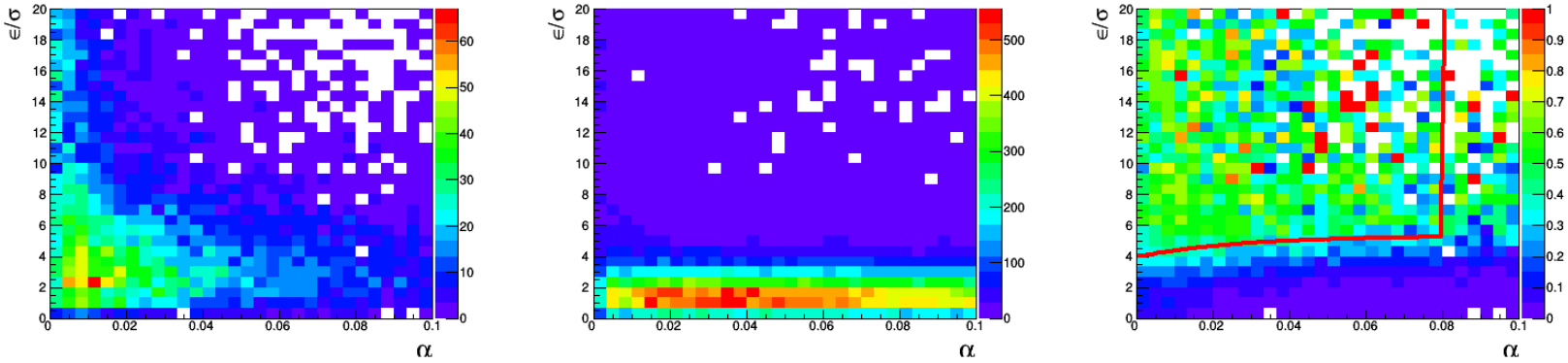

Before Recovery

- The new reconstruction solves the “horn” issue in the transition of barrel/endcap calo.
  - The “Non reconstructed PFO” case is almost gone.
- The “other reasons” (vertex fitting problems) is worst.
  - Maybe solved with the reprocessing of the vertexing?

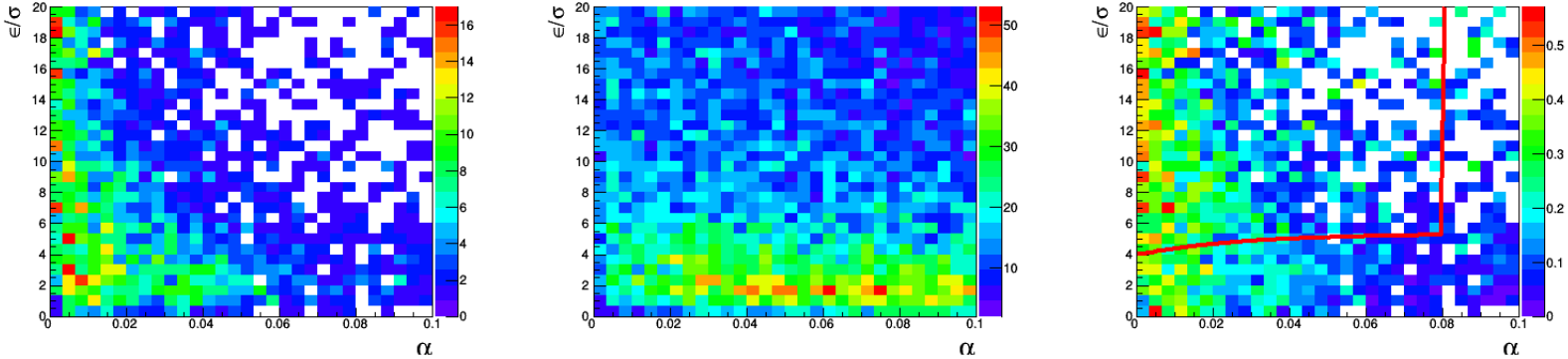
# Track/Vertex DBD vs IDR ($b\bar{b}$, 500GeV, left pol.)

## Tune of the recovery method

- DBD

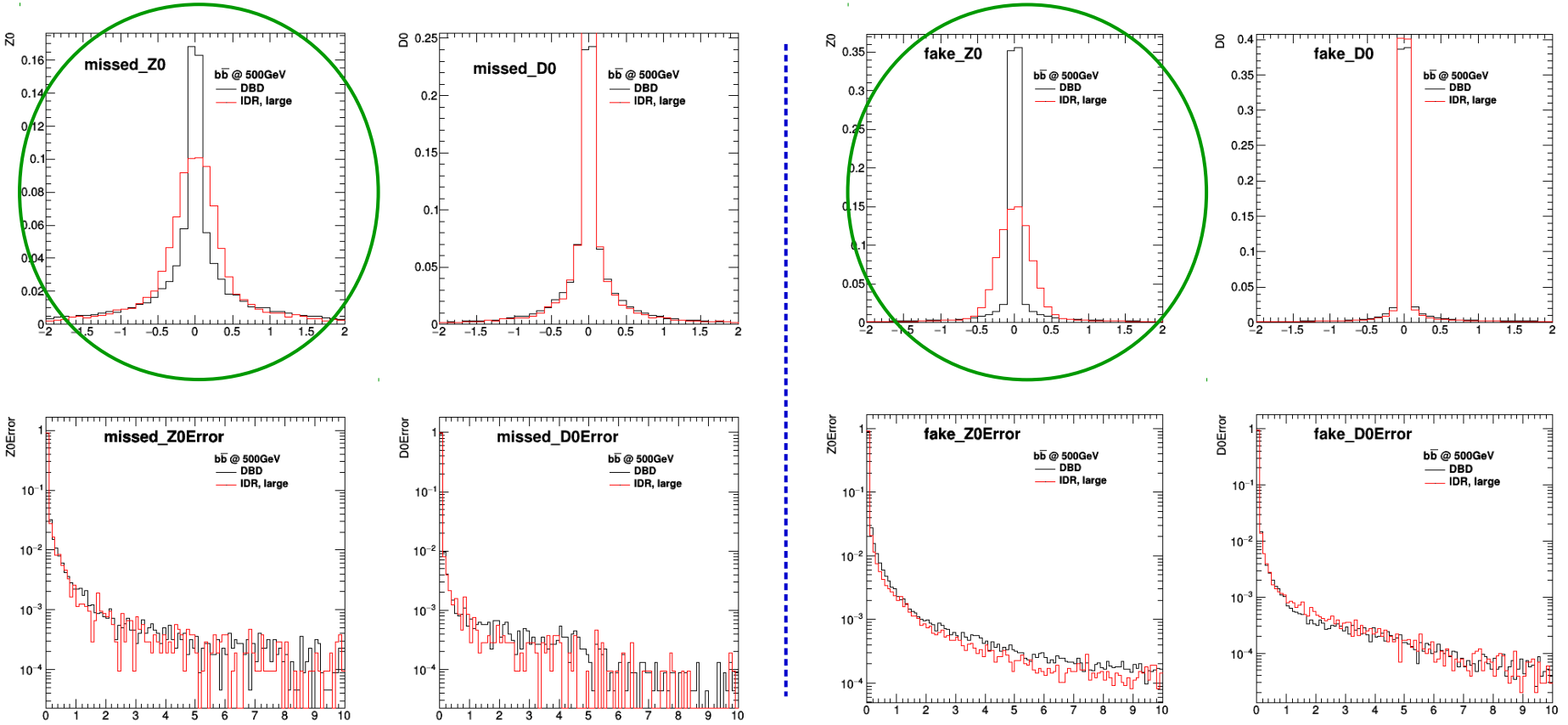



- IDR, large model




$$\epsilon/\sigma = d_0/\sigma_{d_0} + z_0/\sigma_{z_0}$$

# Z0, d0 differences between DBD and IDR




- Tracks with p>1 GeV.
- There is a clear difference (due to IP smearing) in z0 that needs to be taken into account.

# Summary (track recovery)

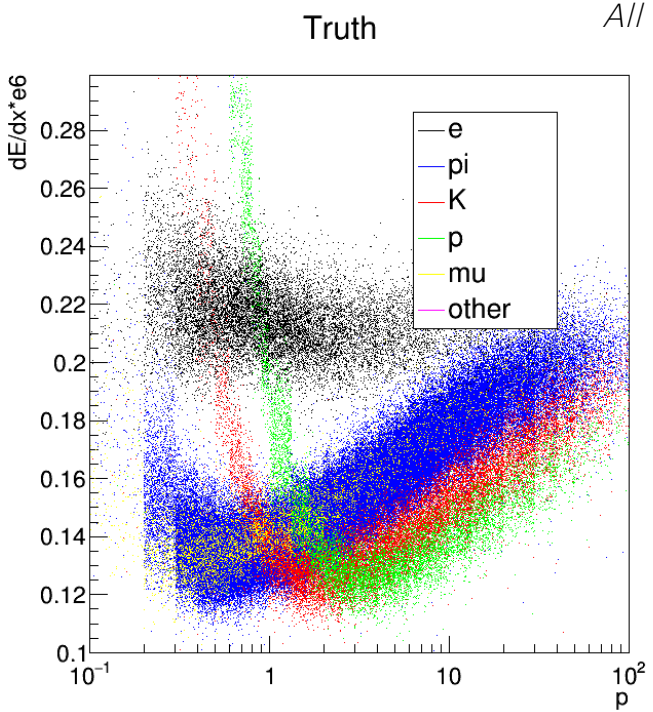
- IDR reconstruction seems to have solved the issue with the non-assigned PFOs, which was specially dramatic in the transition region of the calorimeters.
- Now we lose much more tracks for fitting problems… probably because we need to reprocess the vertexing taking into account the smearing of the IP.
- The issue in the TPC endplate region is still present

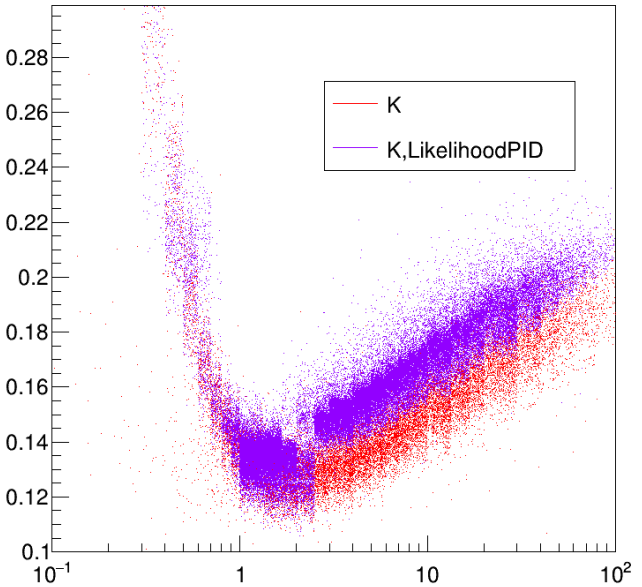
- The offset significance is drastically different for the new samples
  - It is most probably due to the smearing of the IP. We will implement a correction for it in the processor.

# Change of topic: dEdx for kaon identification

# Reminder: dE/dx (bb, 500GeV, large model)

*All tracks, including primary vertexes*



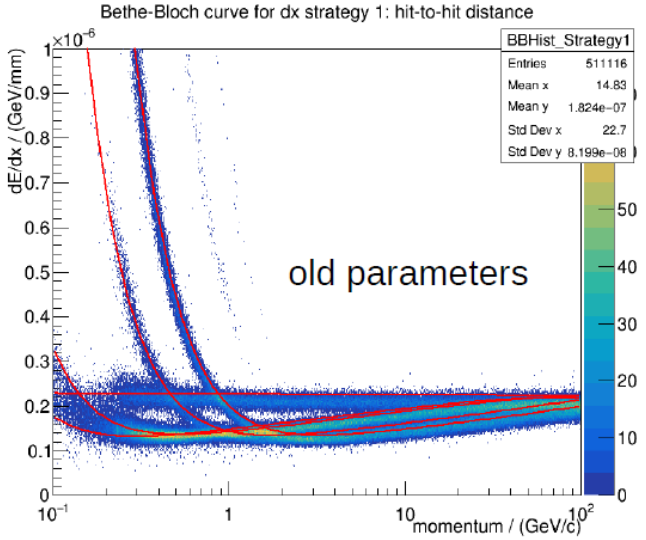



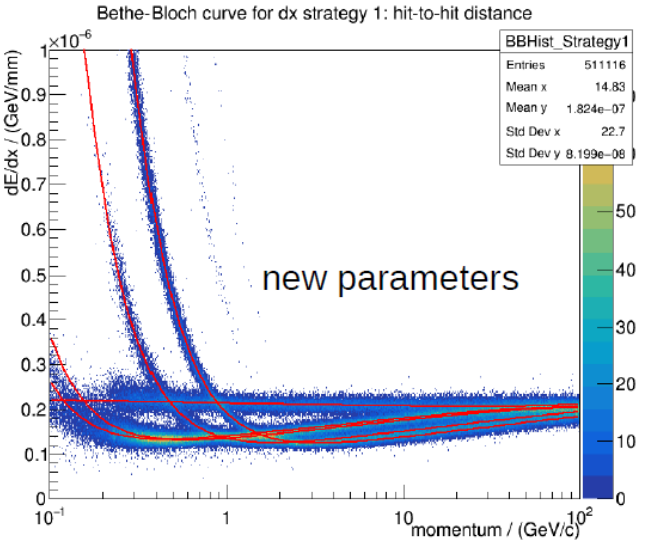

In red, truth kaons (measured dEdx)

- The dEdxPID mistakes kaons and pions at hight momentum. It looks like a simple bug or issue of the parametrization.
- Same for LikelihoodPID since it relies on same algorithm for high momentum.
- For low momentum, both perform better than the simple parametrization. Specially the LikelihoodPID.

# Comparison

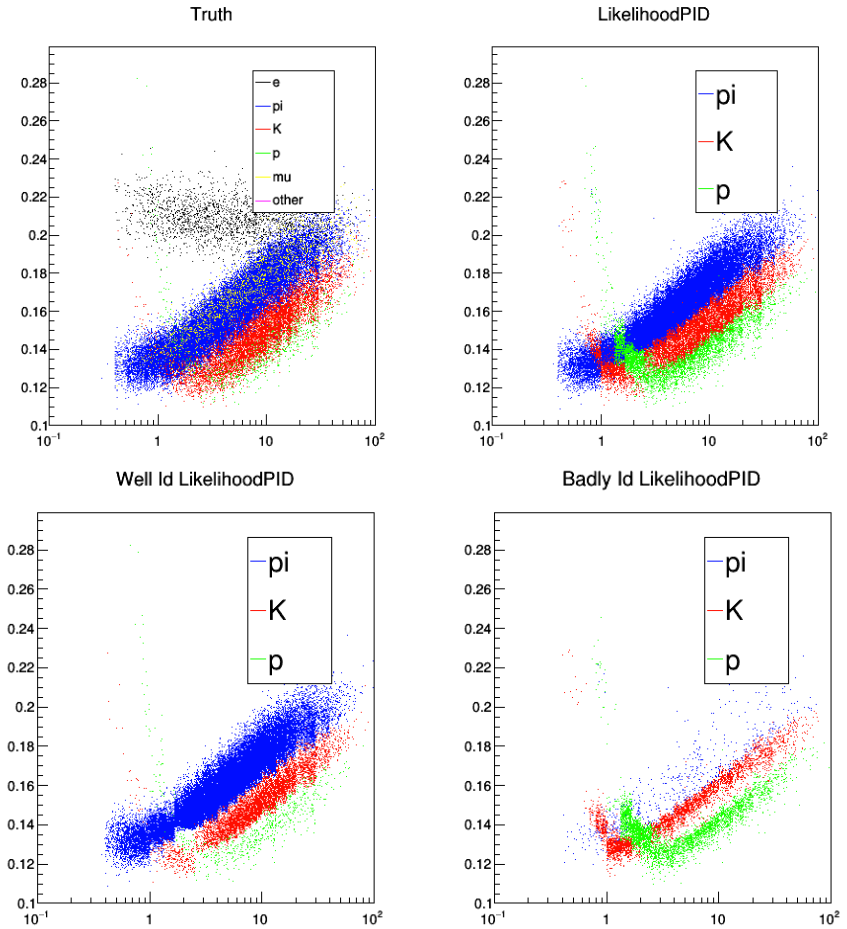
- Likely cause: not-up-to-date parametrisation of Bethe-Bloch curve of expected dE/dx values in dE/dx-PID (inside LikelihoodPIDProcessor)
- Proposed solution: Get new parameters by fitting to current MC-data
- Comparison of parameterised curves with MC-data

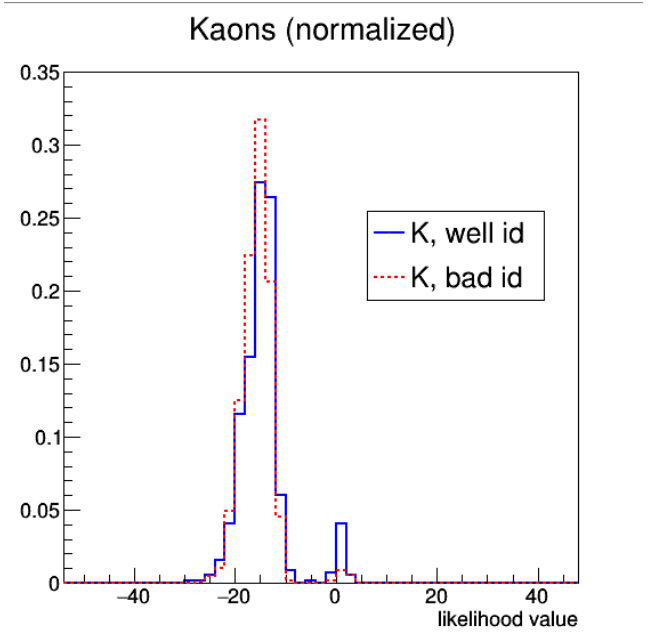


# Performance of the new parametrization

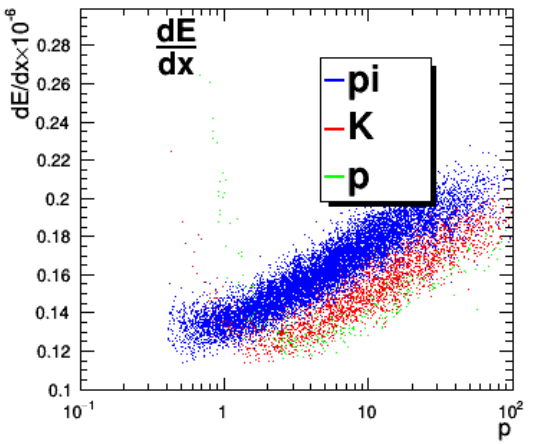
- New Parametrization… still lot of contamination from pions identified as kaons

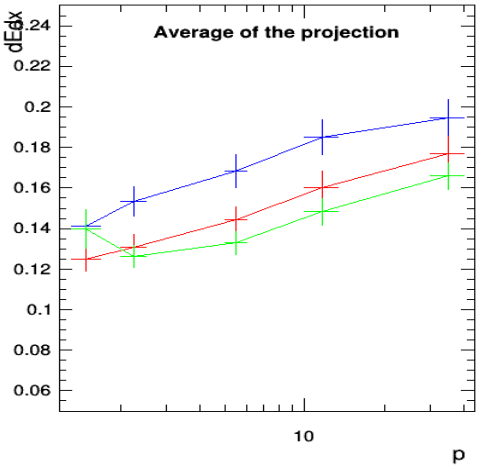


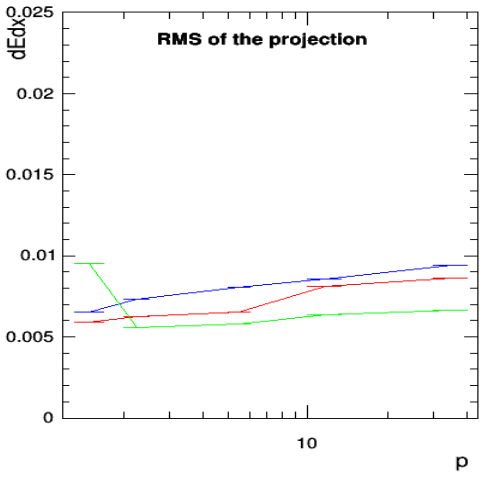



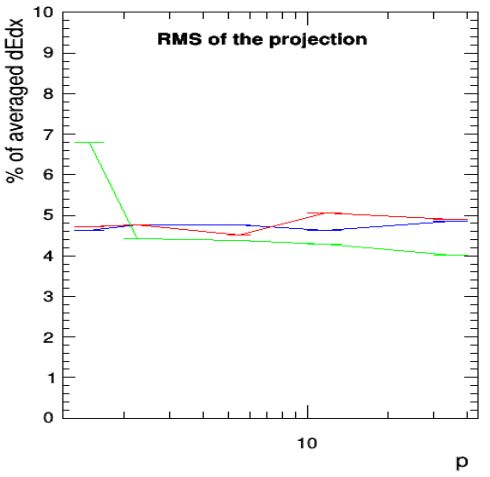
# How well dEdx separates kaons from other hadrons?

- Only tracks in displaced vertexes
- It seems that the hadrons can be quite well separated by dEdx with 1sigma distance criteria.



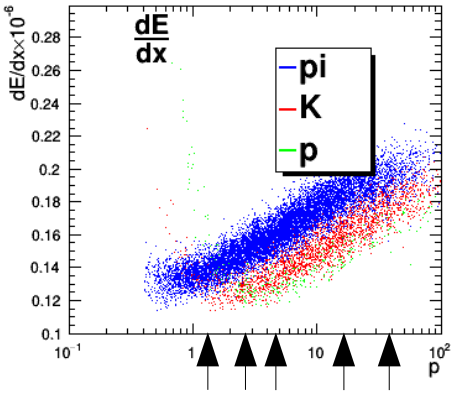



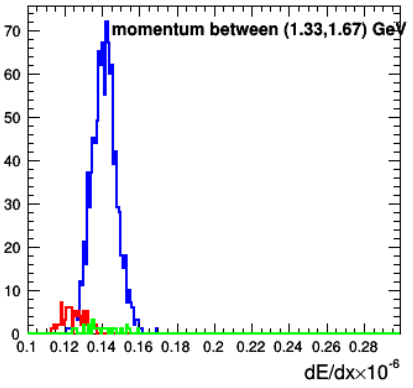



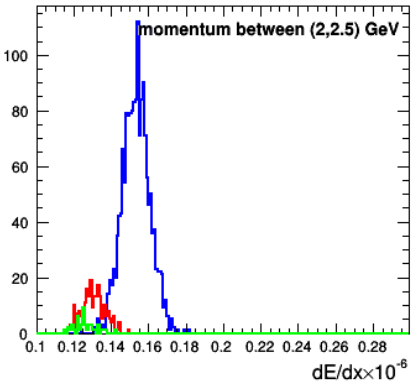



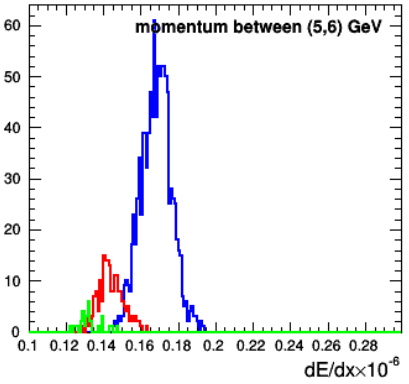
# How well dEdx separates kaons from other hadrons?

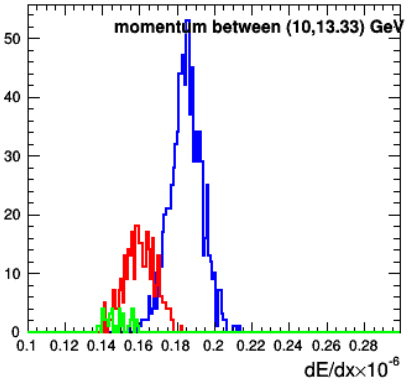
- Only tracks in displaced vertexes
- **But this is clearly process and energy dependent (it depends on the proportion of hadrons of each type)**.
- How is it done in the LikelihoodPID ?

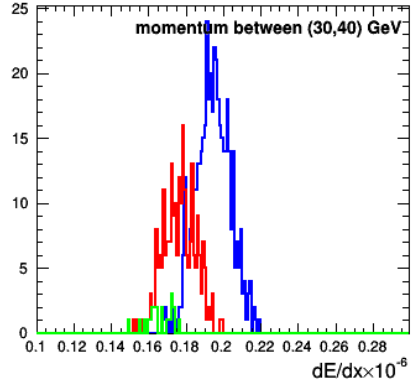


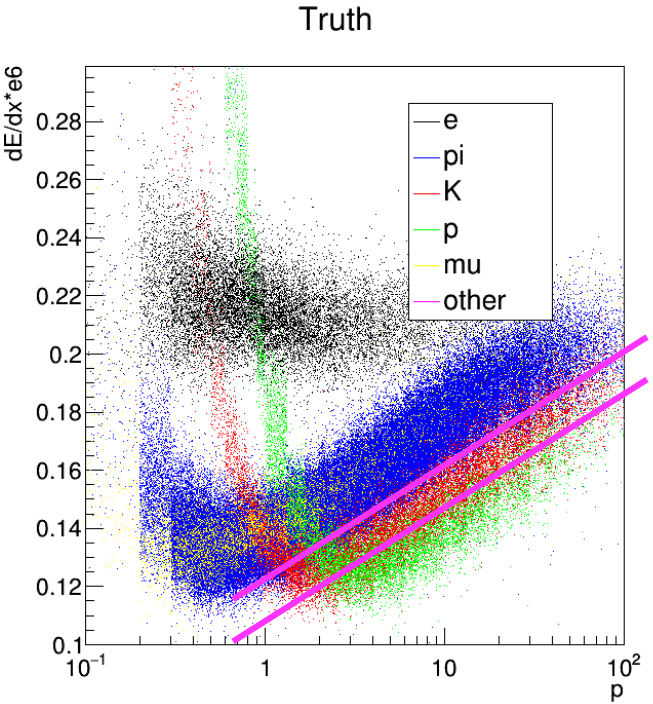



# Summary/conclusions

**We wrote a solution for our analysis, in which we only rely on Kaon identification,** ignoring the performance for pion or proton.

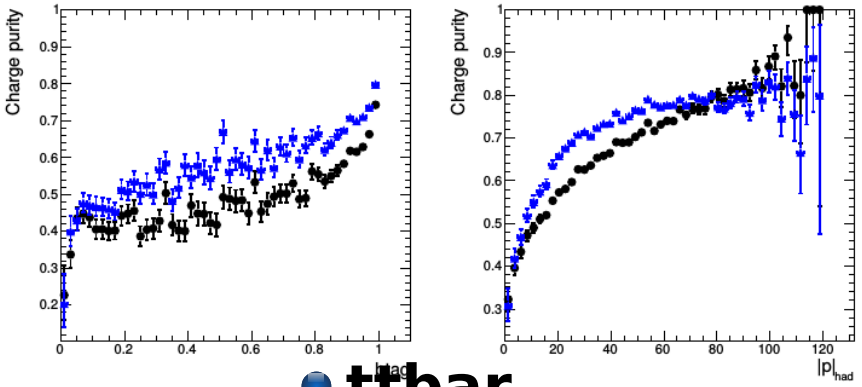
- A **new PIDalgorithm** was created and saved in the PIDHandler of the **PandoraPFOs**
  - KaonTagger
  - Without likelihood or probability value.
- Optimized for kaon identification on secondary tracks only

- **Can/should the results of these studies be integrated in the official LikelihoodPID ?**

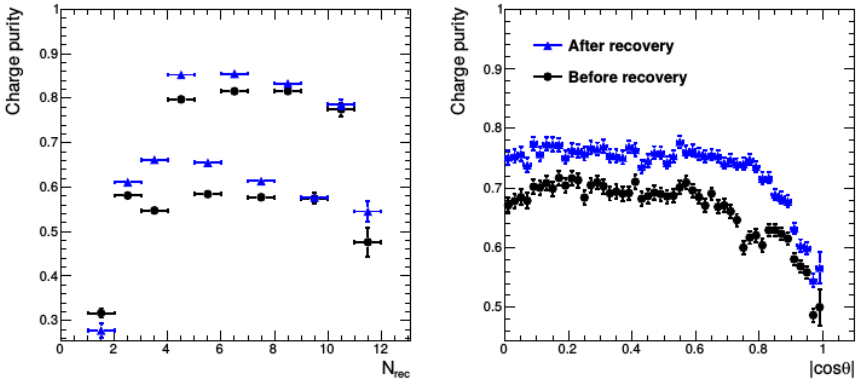


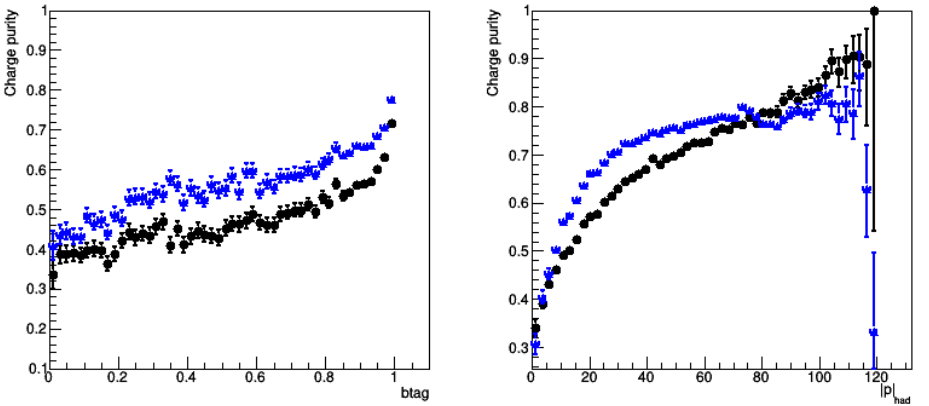
# Back-up

# Track/Vertex Recovery (DBD)

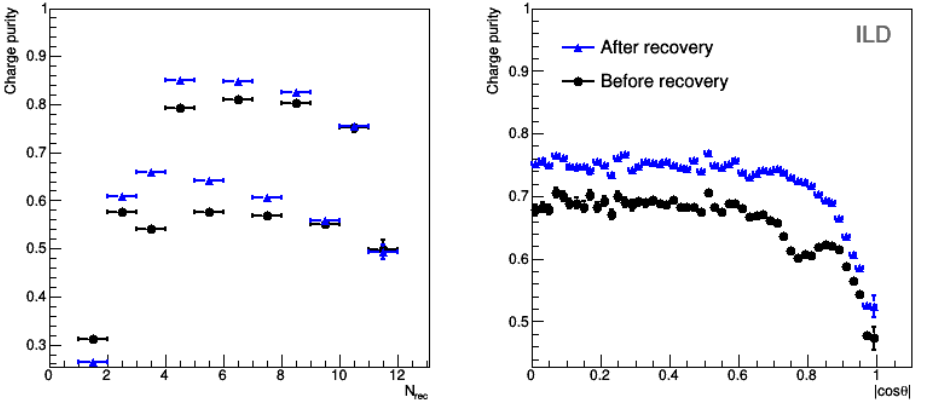



- ttbar



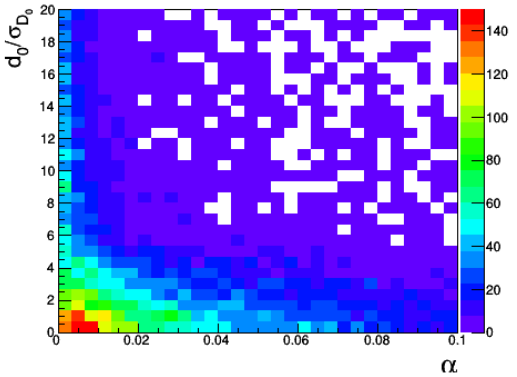

- bb, 250GeV

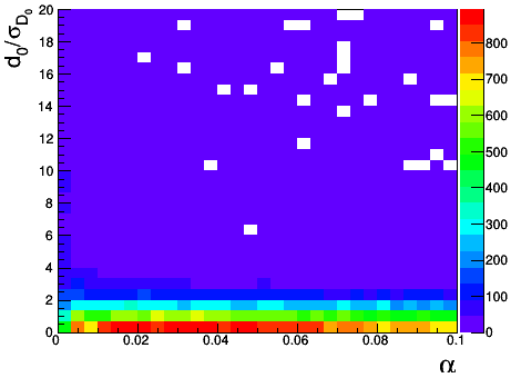


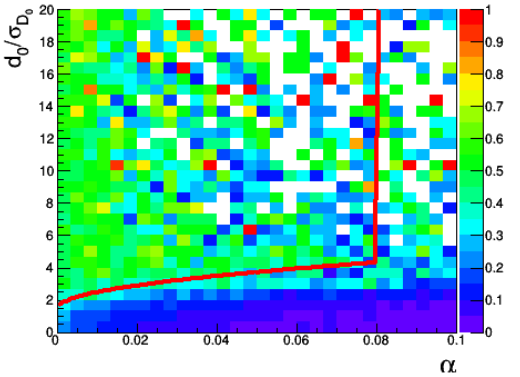
# Track/Vertex DBD vs IDR ($b\bar{b}$, 500GeV, left pol.)

Tune of the recovery method,**only using d0**

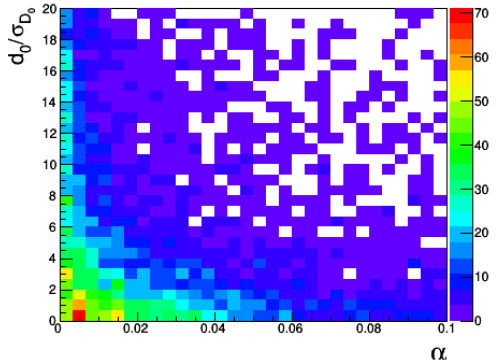
- DBD

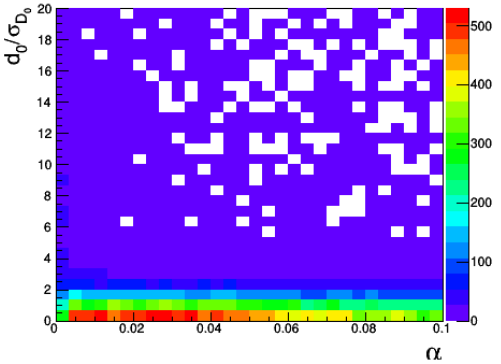


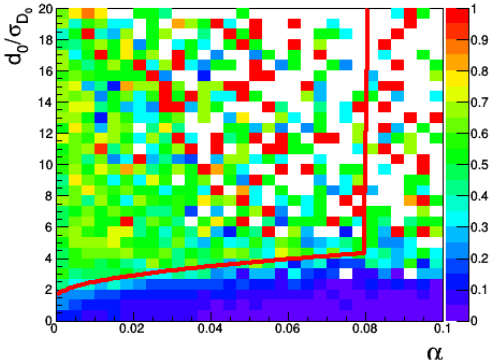




- IDR, large model

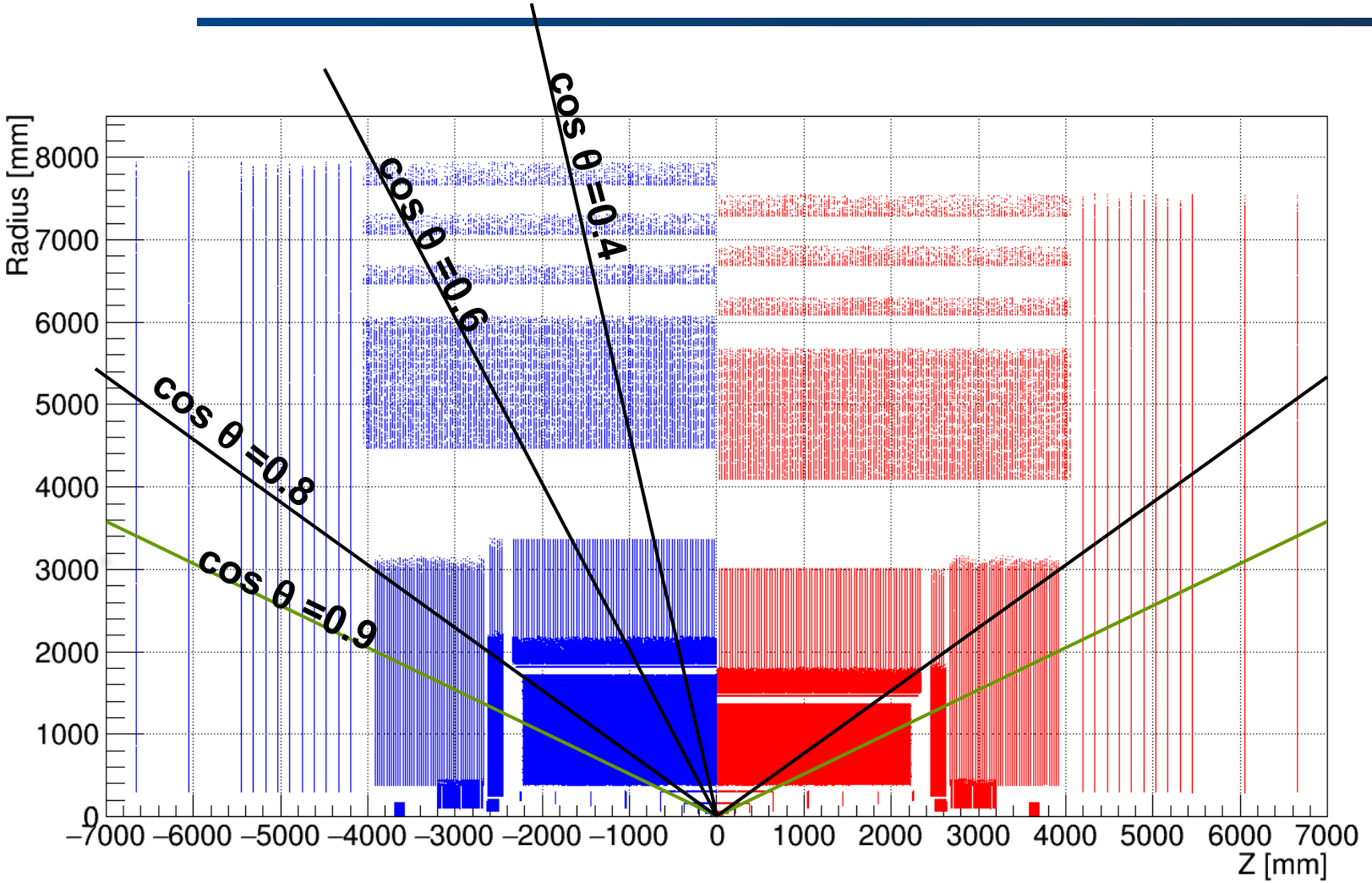


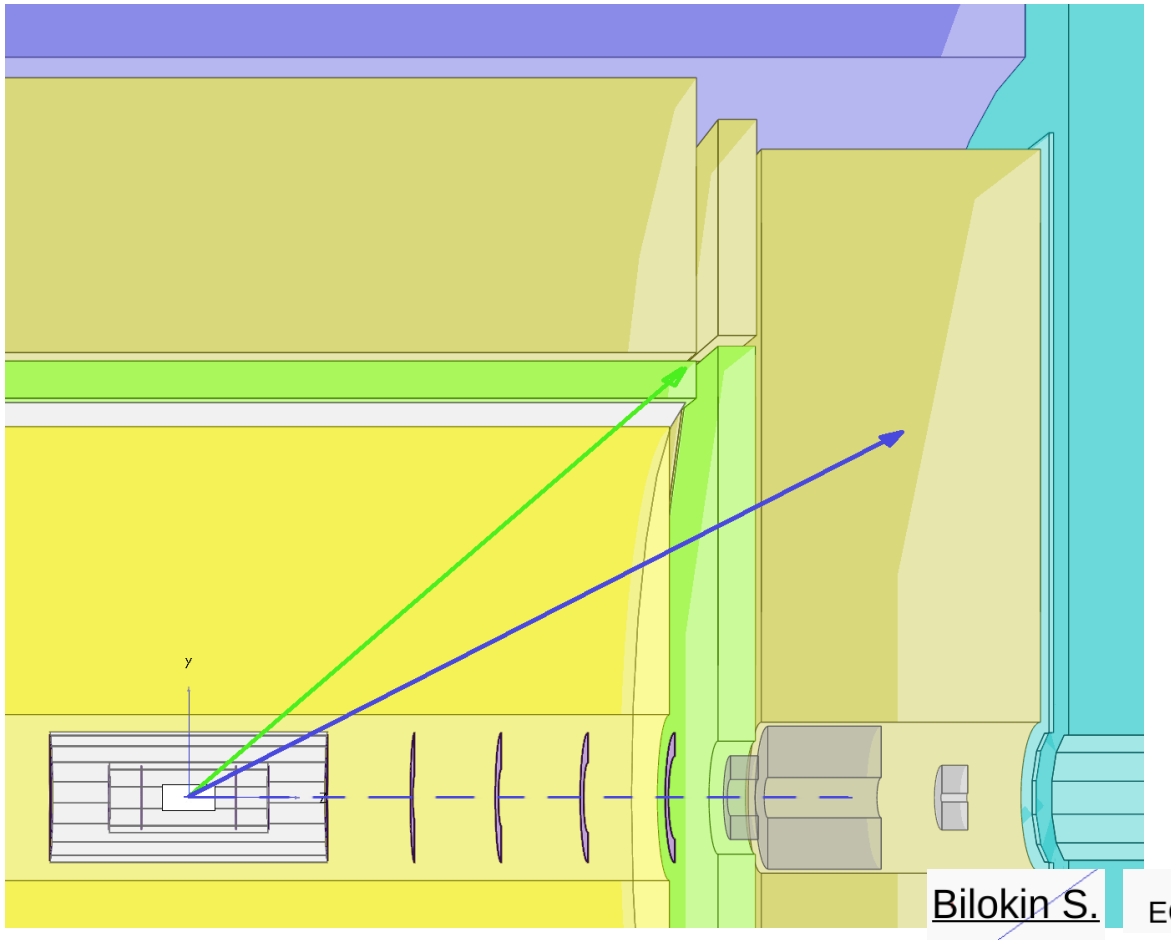




$$\epsilon/\sigma = d_0/\sigma_{d_0} + z_0/\sigma_{z_0}$$

# Impact of using the vertex restorer: efficiency



# ILD geometry




Bilokin S. ECFA LC Workshop 04/06/16