

TDR plots updates

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for the Pandora Team

**DUNE FD Sim/Reco meeting
15th of April 2019**



Overview

TO-DO LIST:

- Some plots were missing (high level reco)
- Some plots need to be updated with MCC11
- Some text needs updating after initial LBNC questions

TODAY:

- Updates on the plots, will follow up updating them in overleaf with the text in the next days



Pattern recognition performance

- **Some plots need to be updated with MCC11**

Different larsoft/dunetpc versions:

MCC11: v07_06_02

MCC10: v06_60_00

But flux file used seems to be the same:

**Flux file: /pnfs/dune/persistent/TaskForce_Flux/
GenieHistFluxFiles/g4lbne_v3r2p4b_FHC_FD_RIK.root**

What else has changed? detsim? Hit reconstruction?

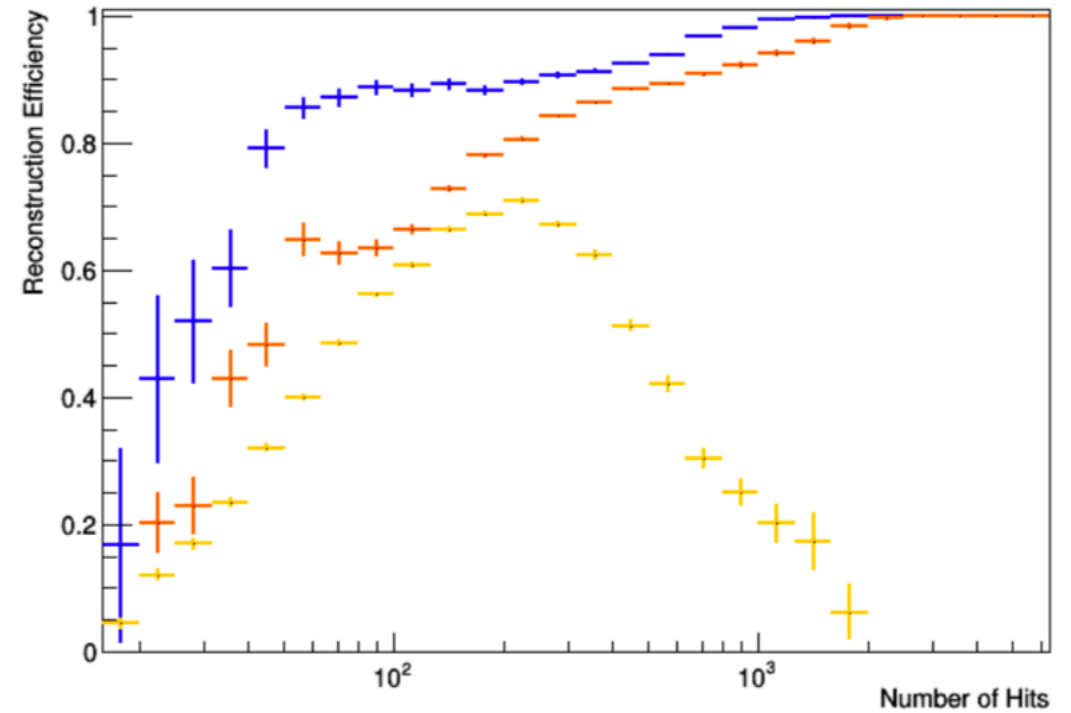
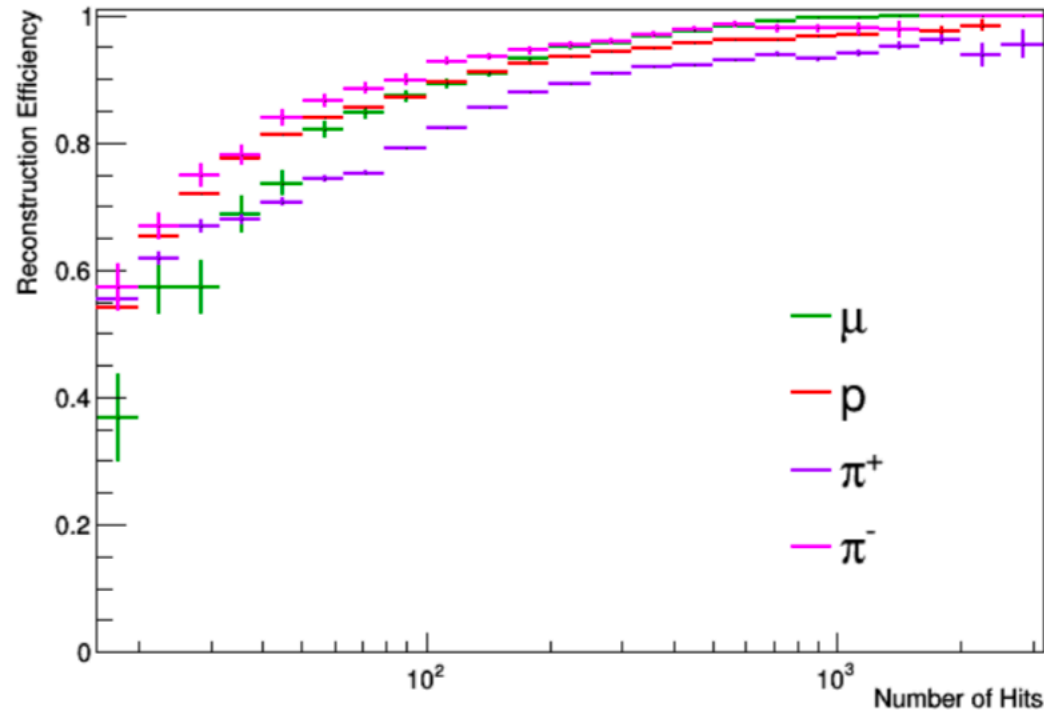
**Results are compatible MCC10 vs MCC11, but I
do see an impact in performance in MCC11**



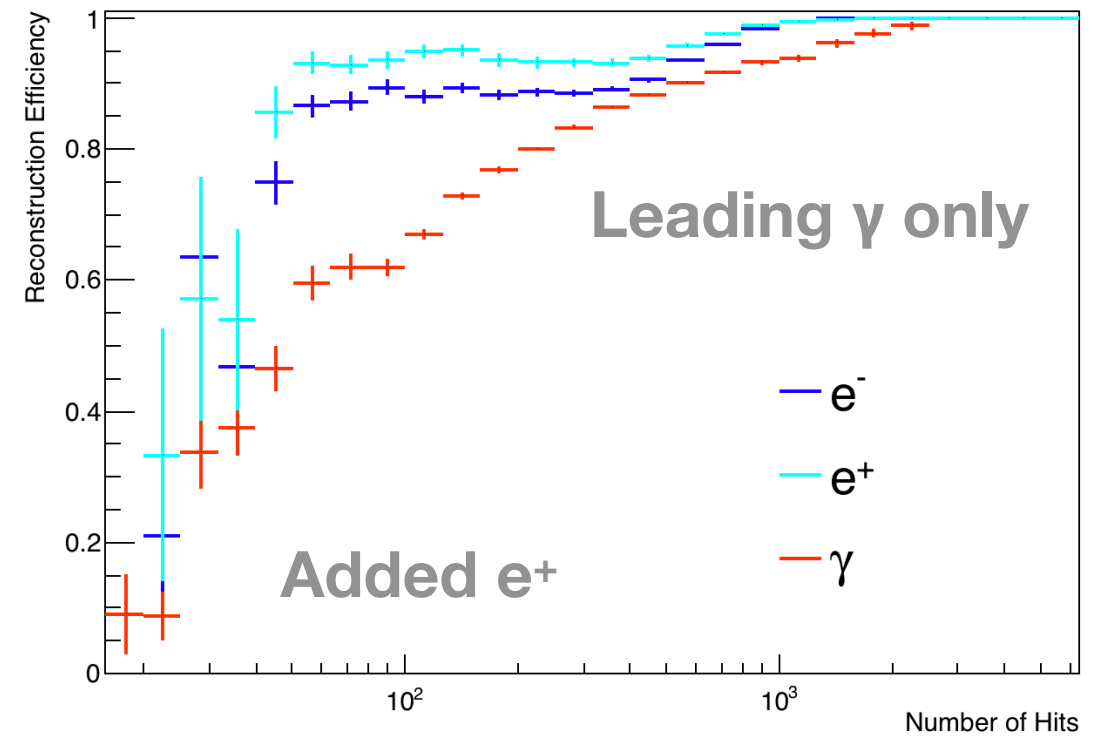
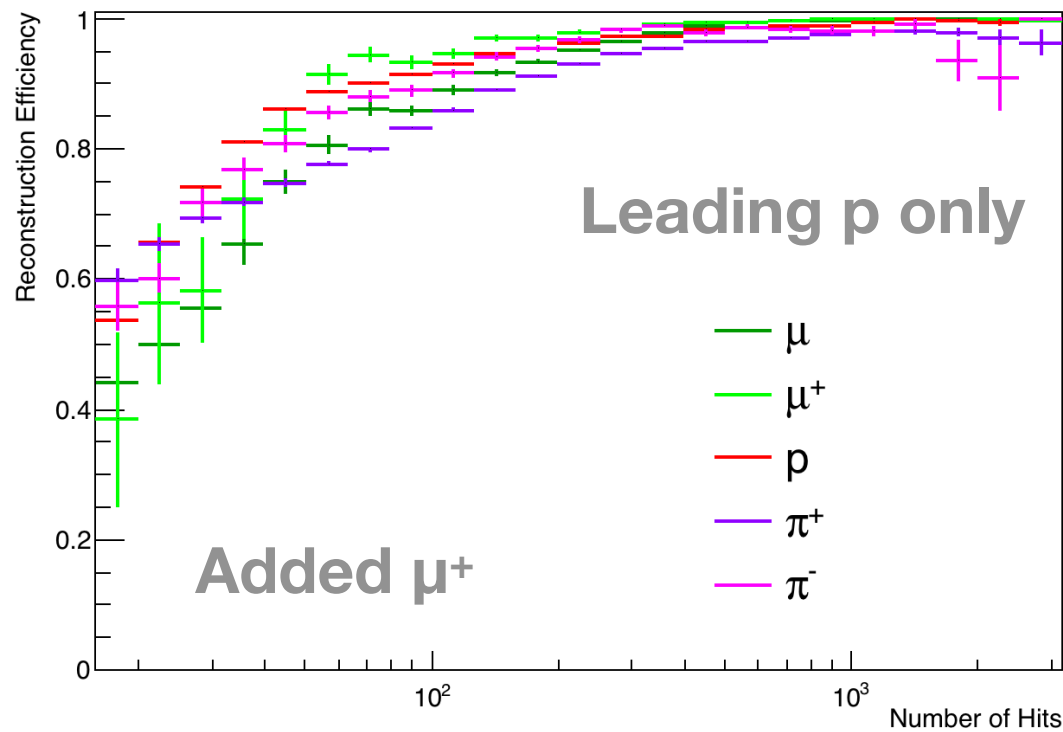
Pattern recognition performance

ALL INTERACTIONS EXCEPT DIS

OLD



NEW



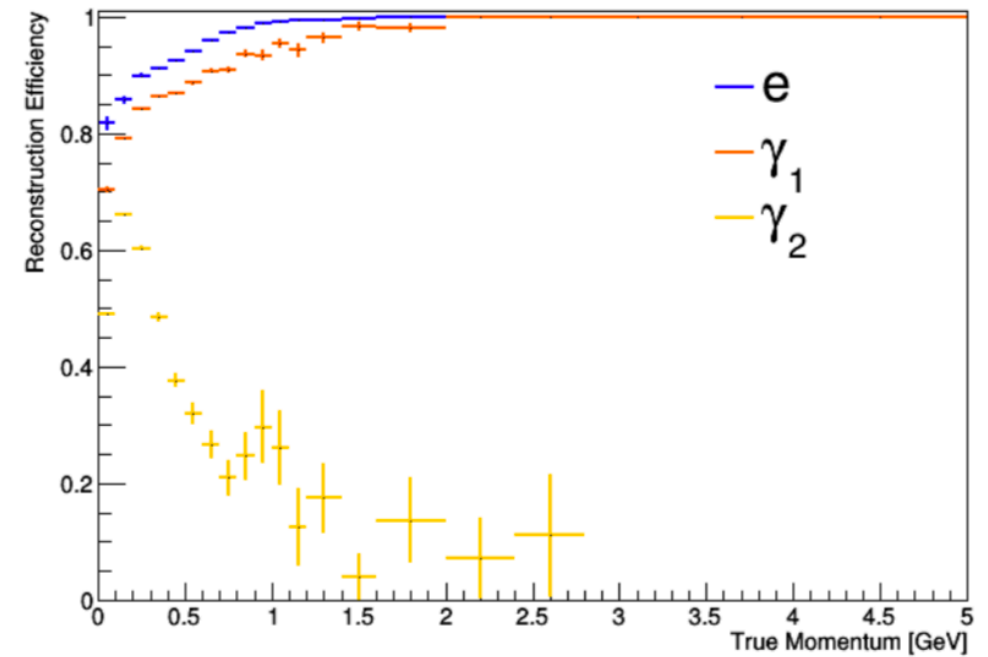
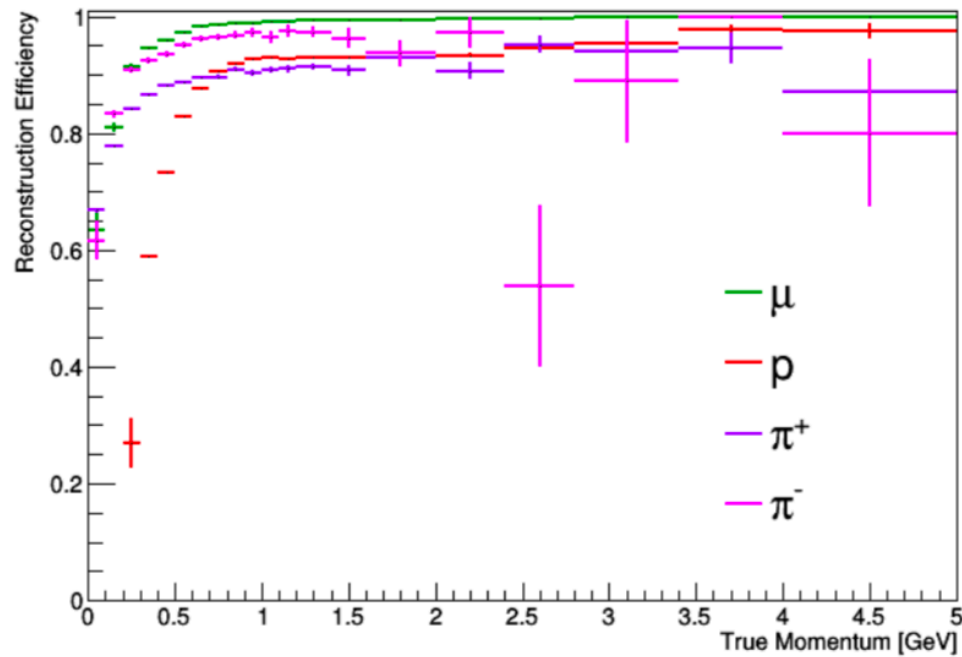
Note: might still try to add tau performance



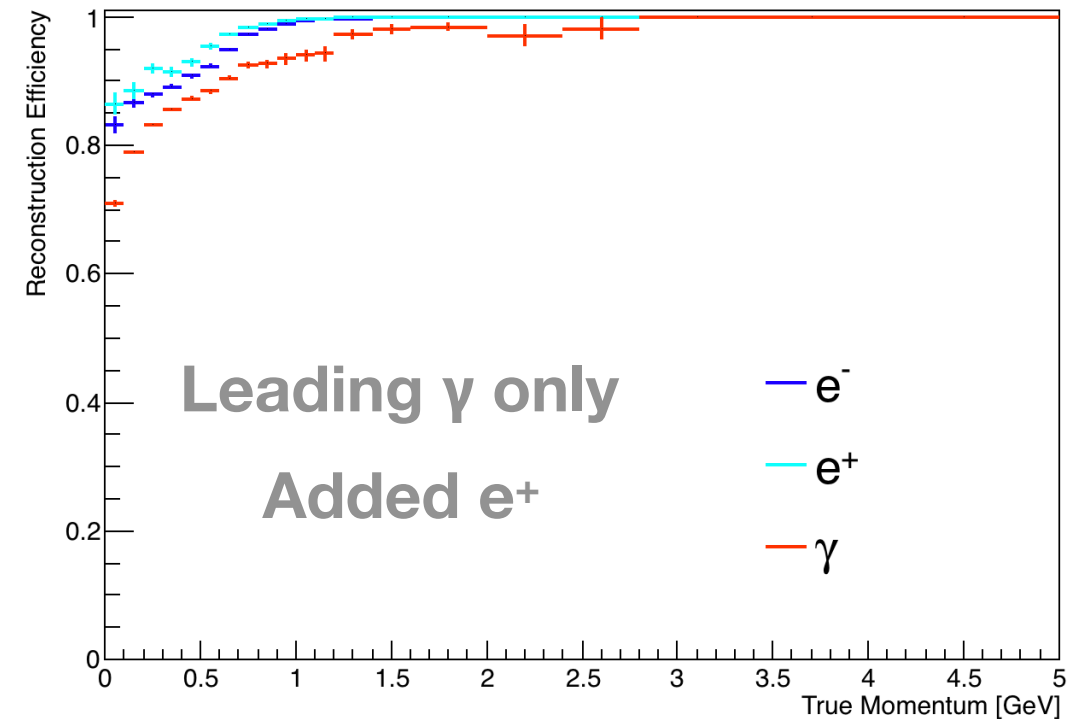
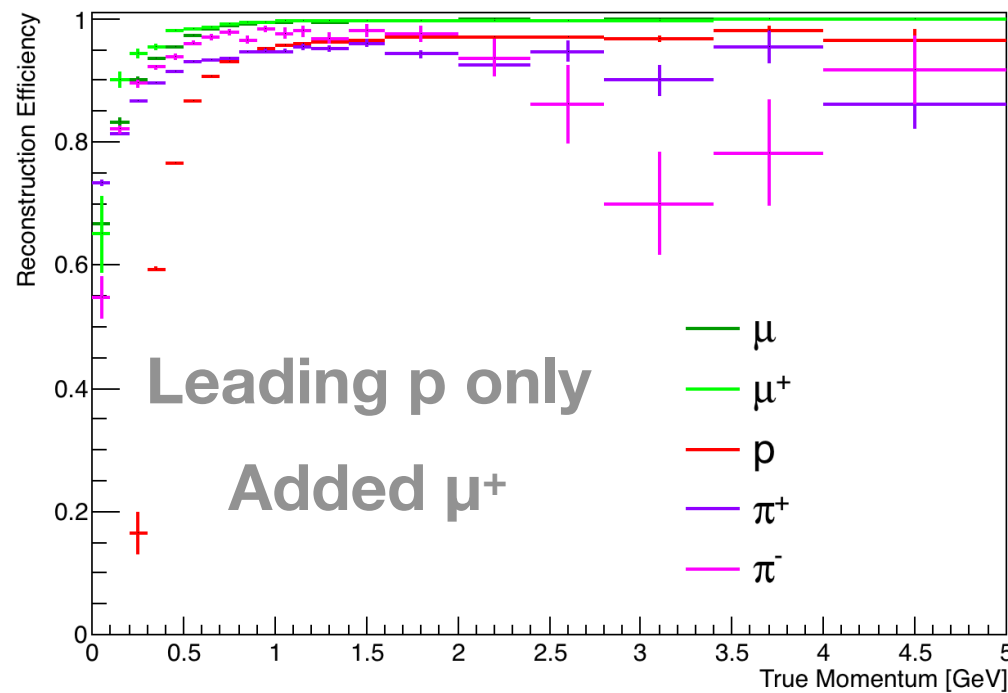
Pattern recognition performance

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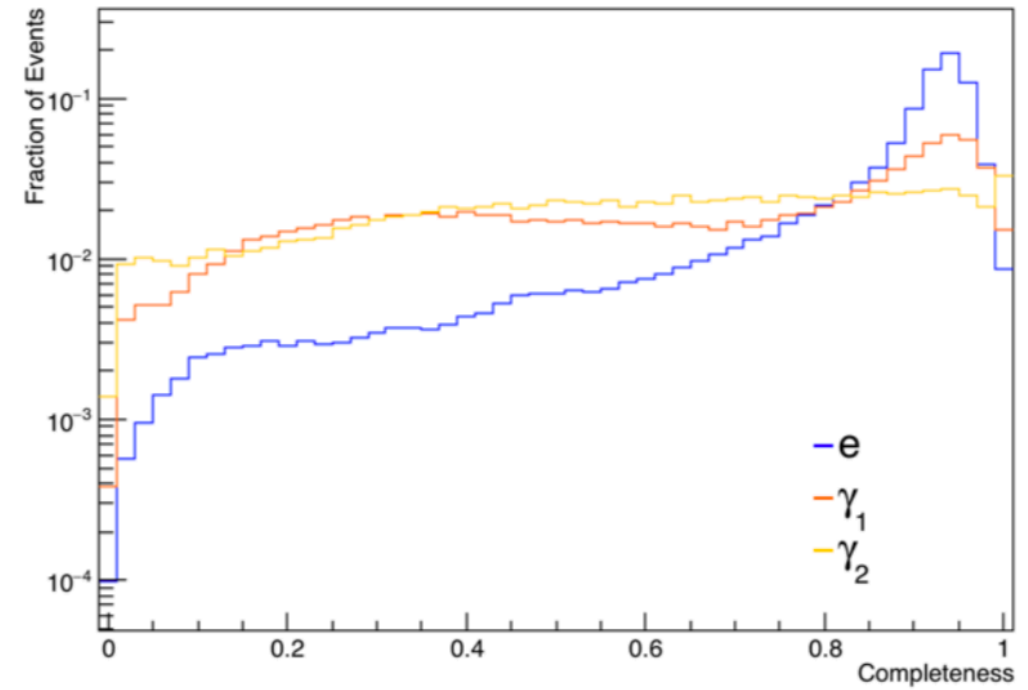
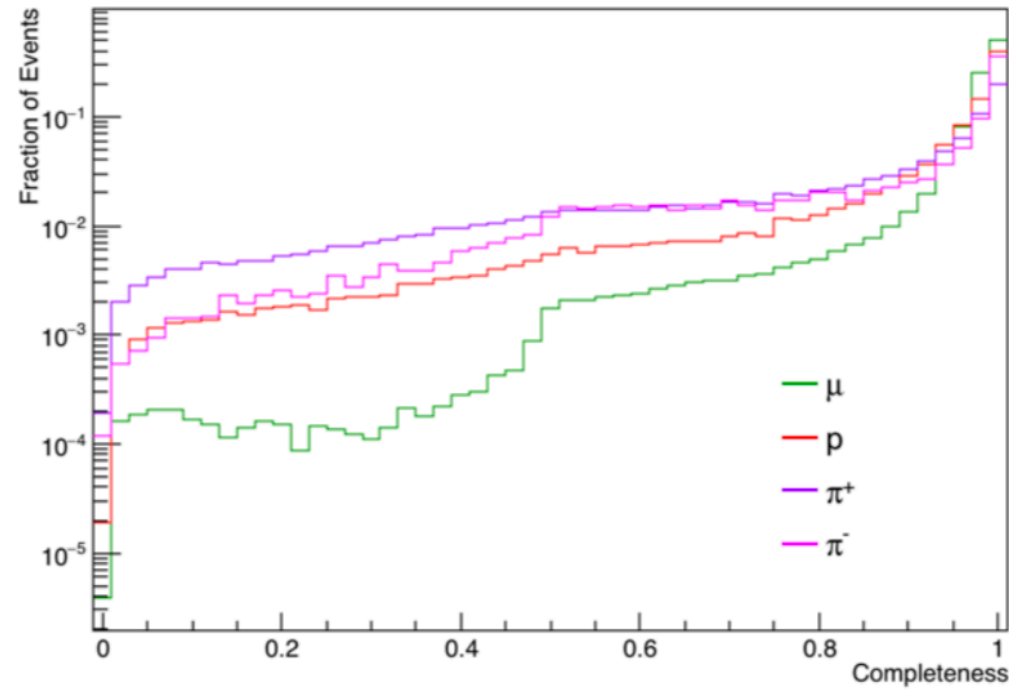
Note: might still try to add tau performance



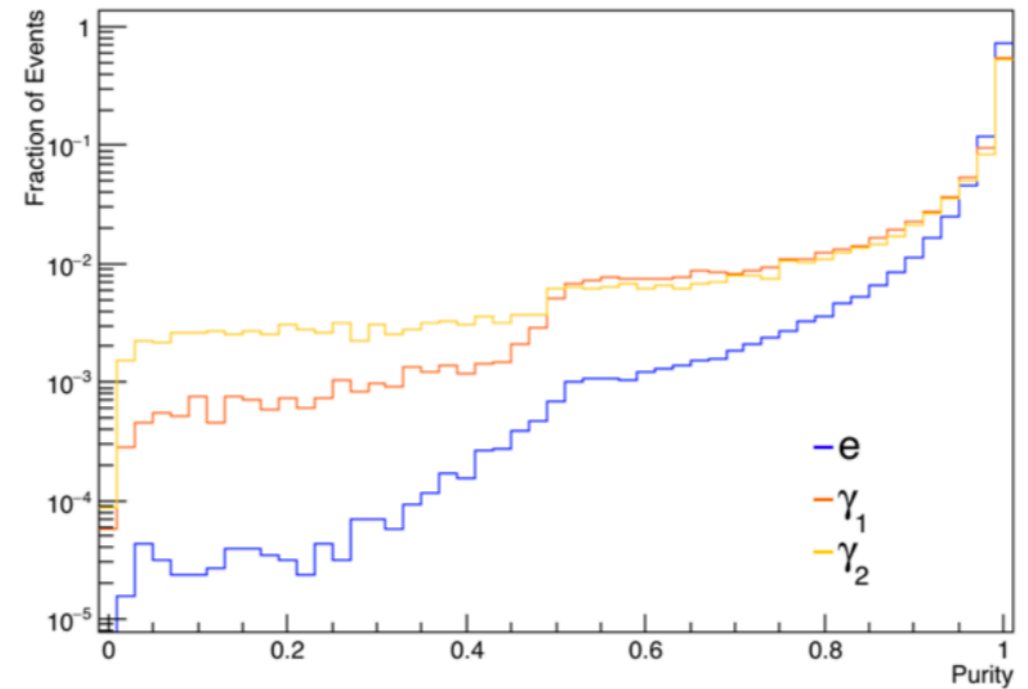
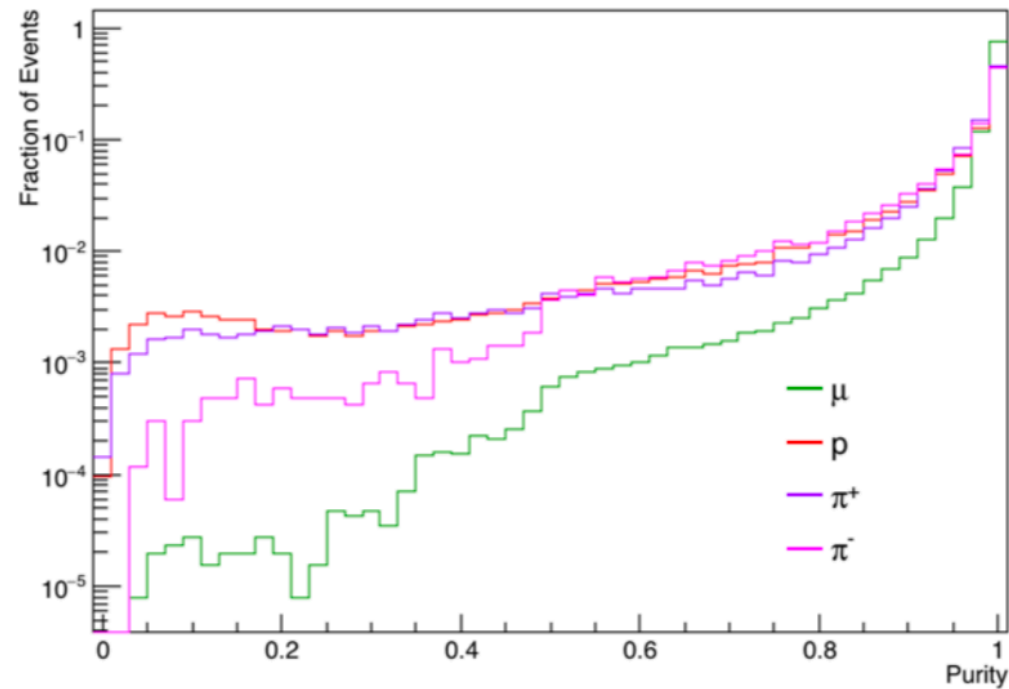
Pattern recognition performance

ALL INTERACTIONS EXCEPT DIS

OLD



Will be updated in the same way





Pattern recognition performance

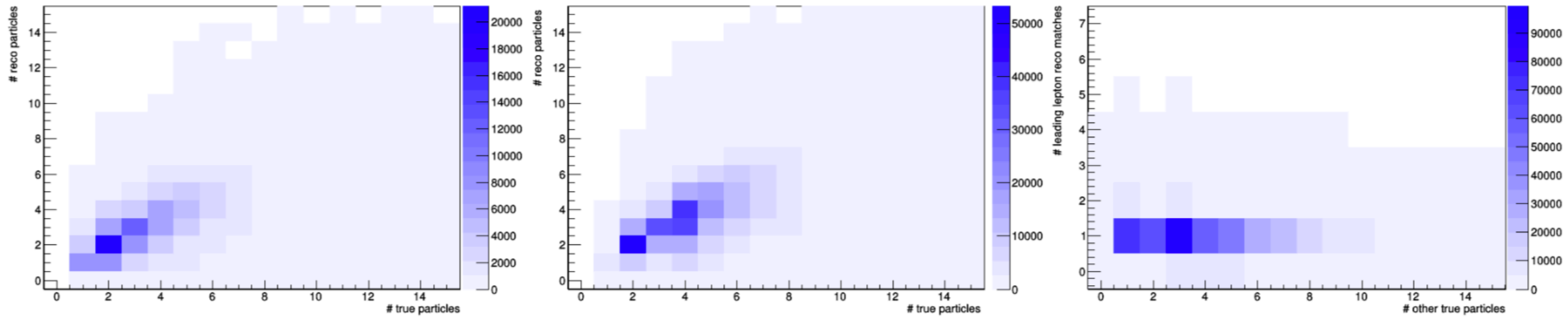
OLD

ONLY DIS INTERACTIONS

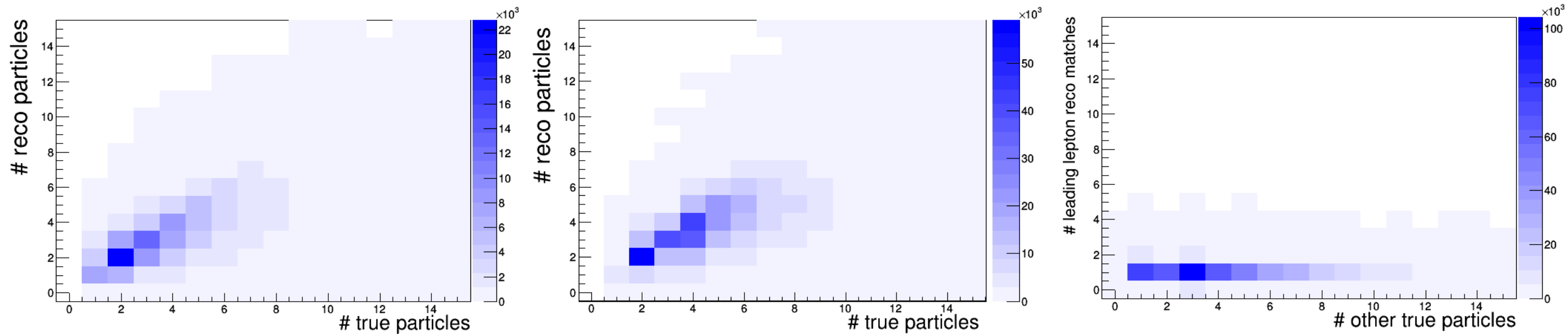
NC DIS

CC DIS

CC DIS: leading lepton



NEW



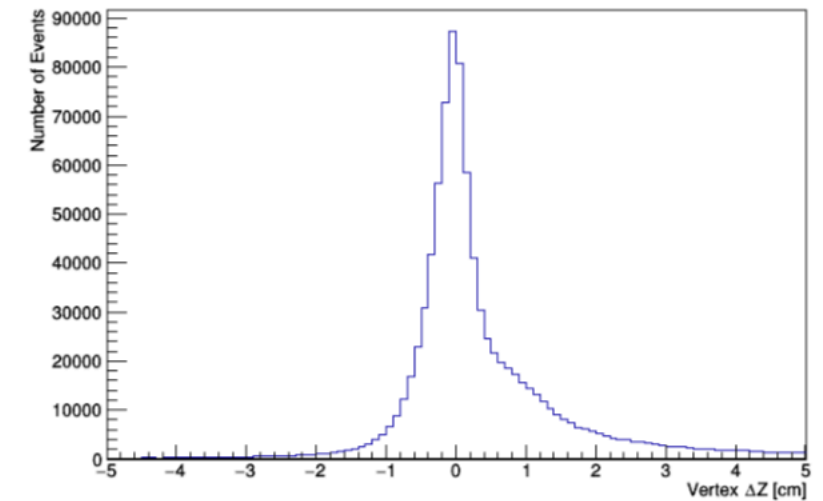
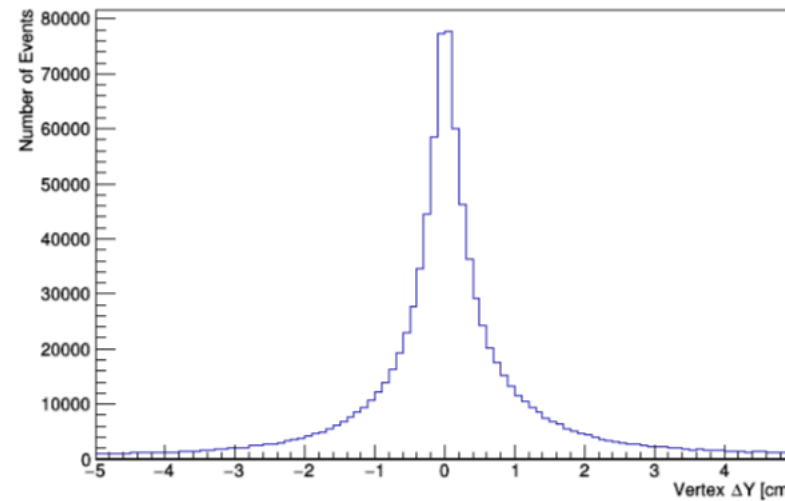
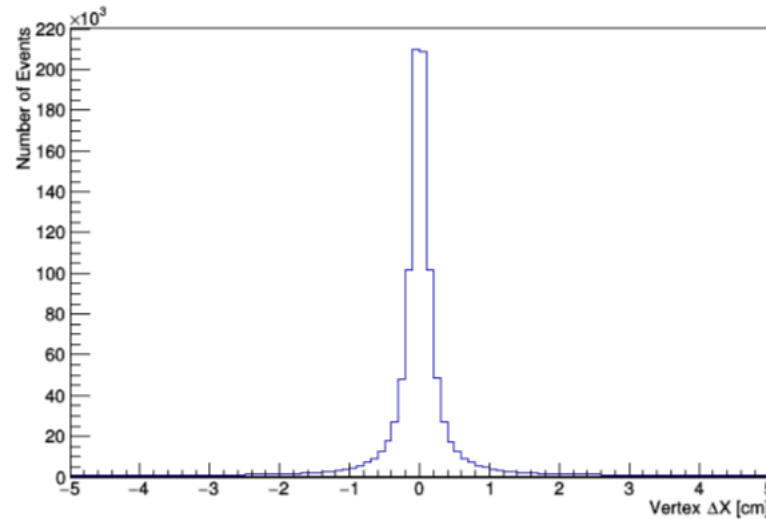


Pattern recognition performance

ALL INTERACTIONS (INCLUDING DIS)

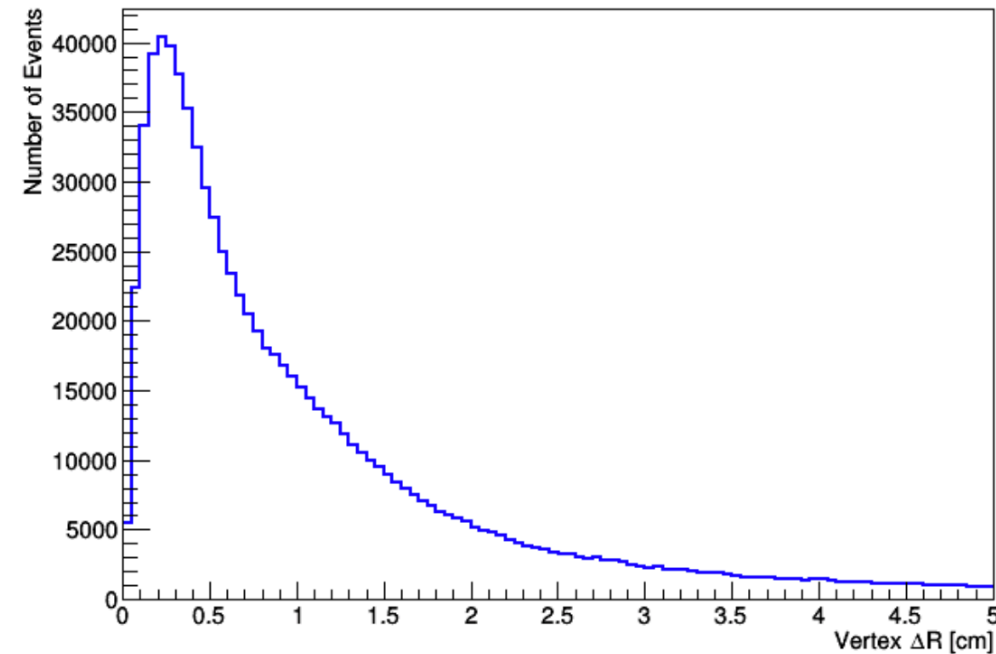
OLD

Neutrino vertex reconstruction



Will be updated in the same way

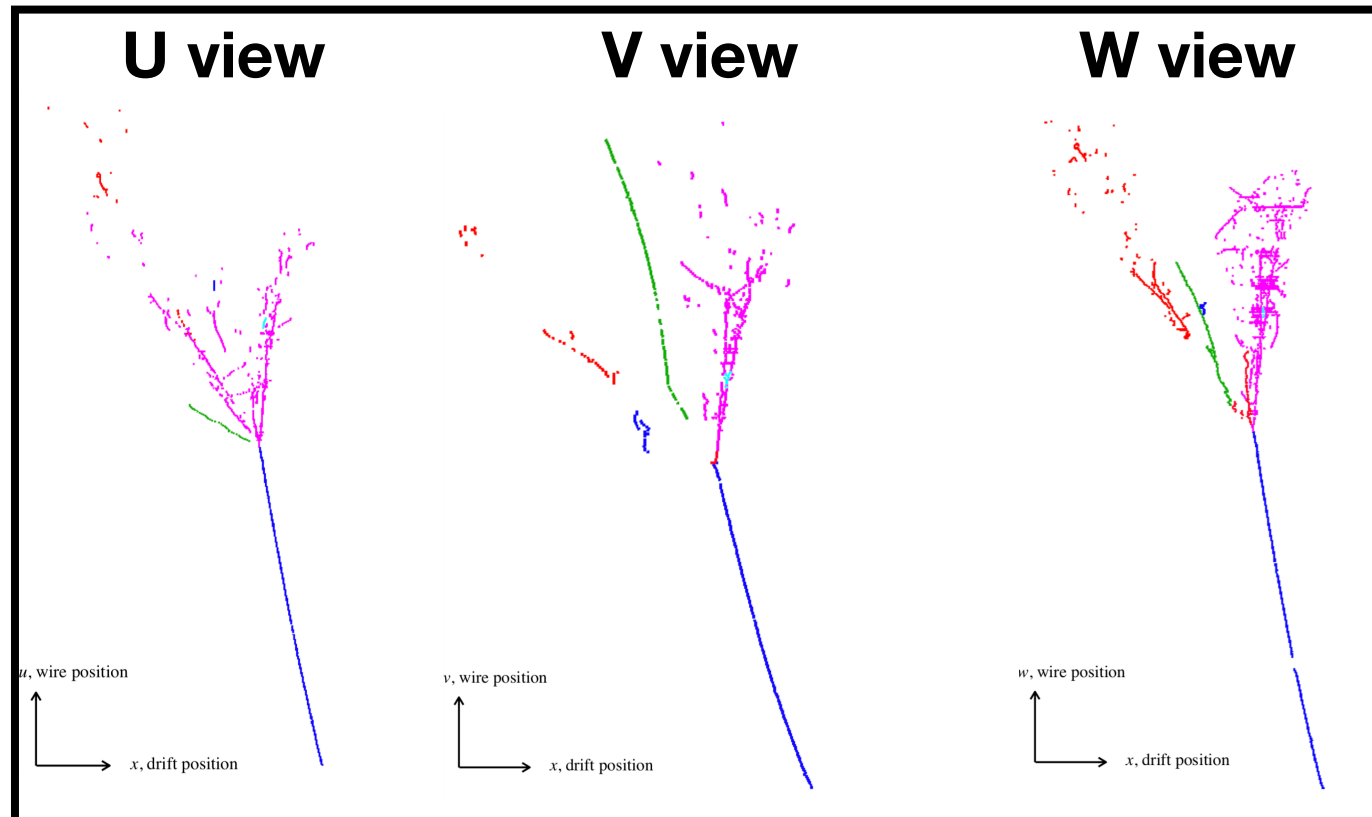
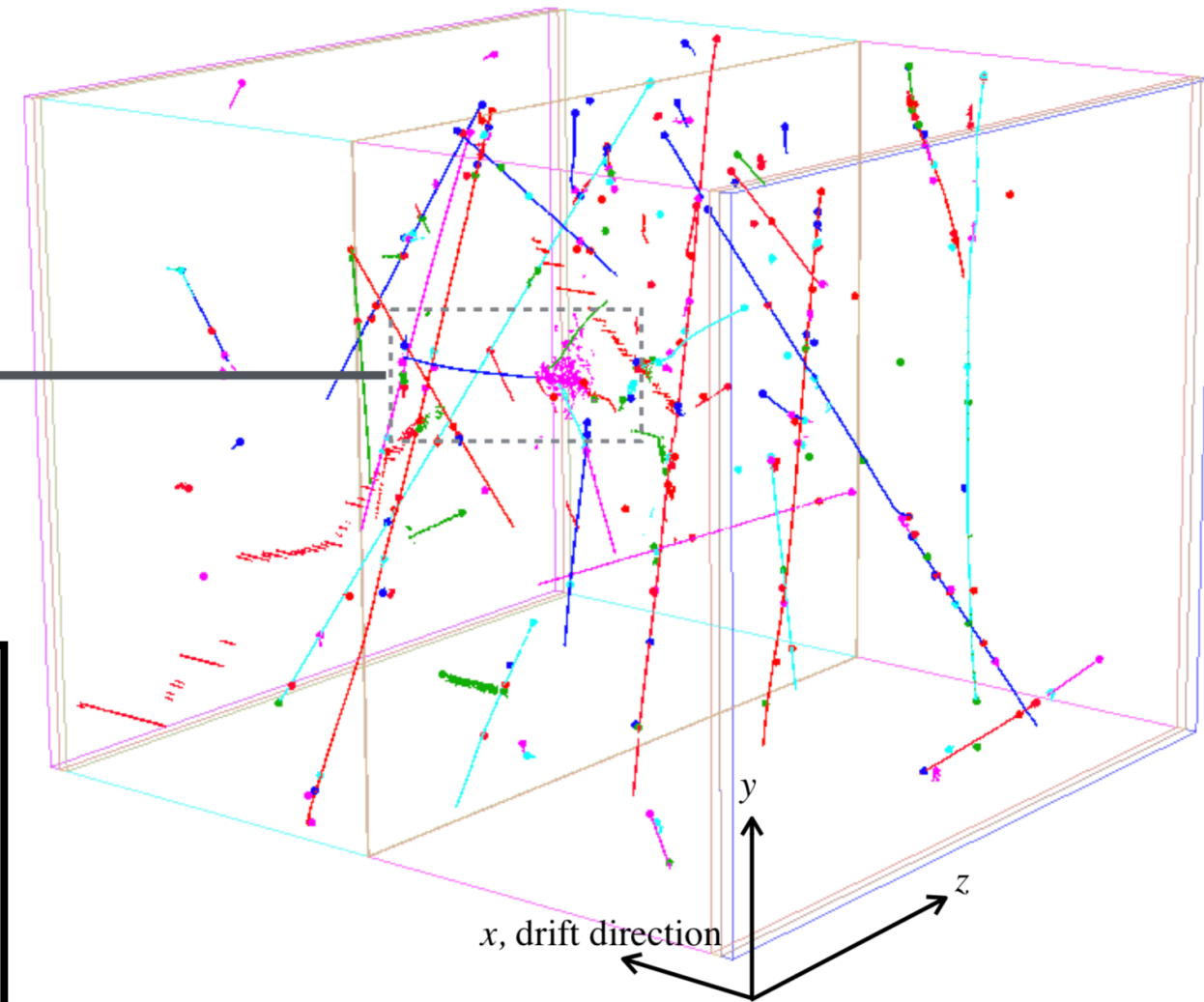
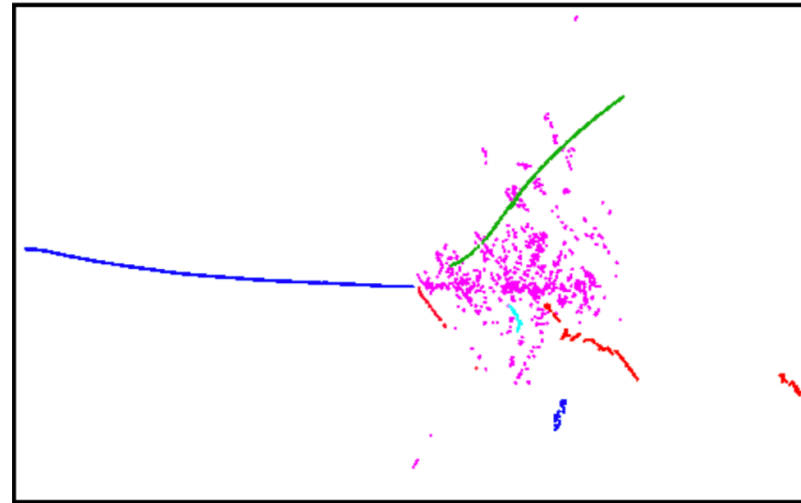
Maybe we should also add DeltaR plot? Seemed useful to answer a question from LBNC





Pattern recognition performance

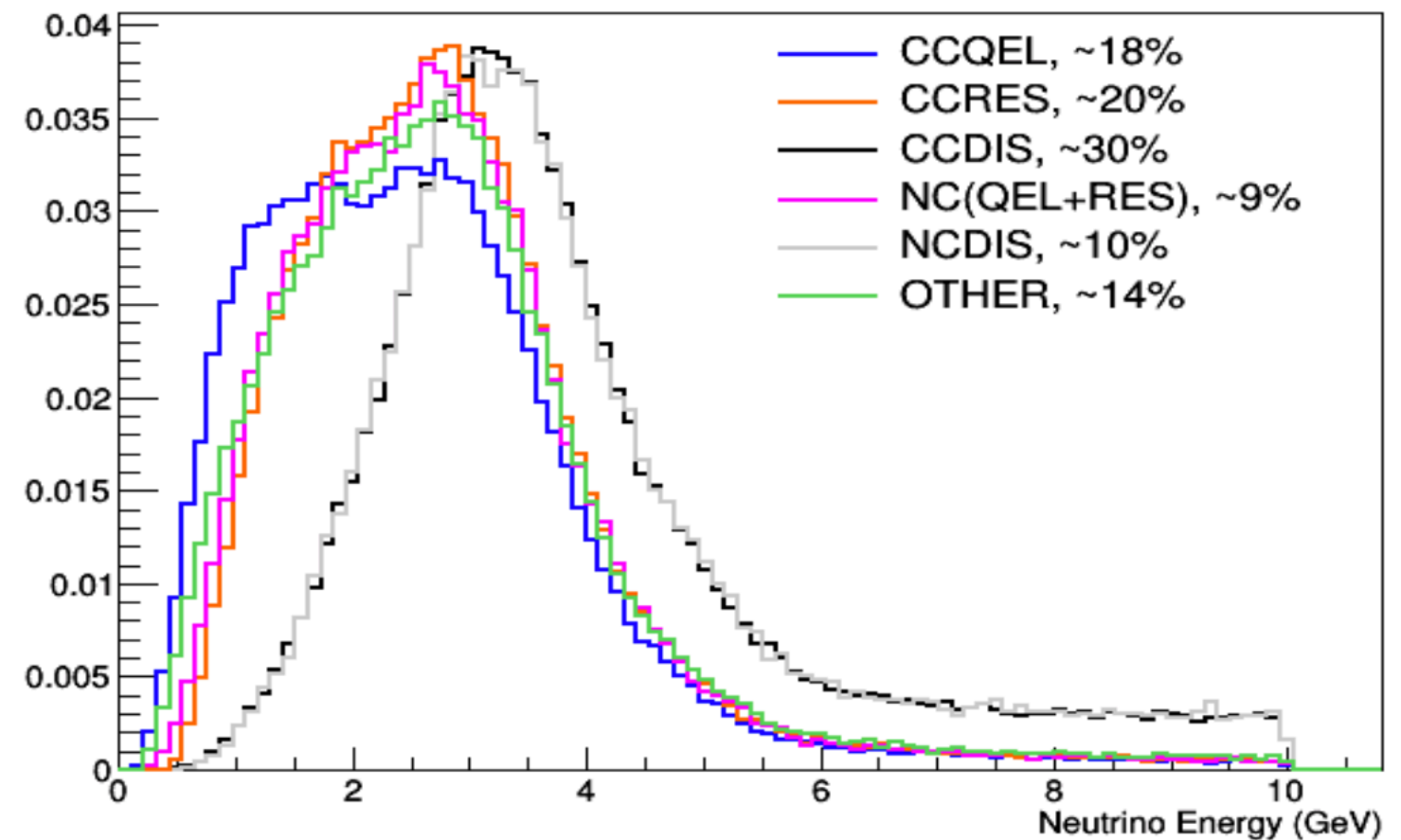
PROTODUNE-SP EVENT EXAMPLE - UPDATED TO USE A DATA ONE (old MC one in backup) - provided by Steve Green





Pattern recognition performance

**ASKED BY LBNC TO ADD
THIS PLOT:
Distribution of interaction
channels as a function of
Energy**



Will be updated in the same way



High level reconstruction: Tracks

For track-like MC primary particles:

Selection is done re-using methods used in Pandora to compute performance metrics: LArContent/LArMonitoring/EventValidation.C

- **Select Final State PFOs (i.e. primaries, not daughters of another PFO)**
- **Select reconstructable MC particles, target and primaries (i.e. produce enough hits* & first long-lived visible in hierarchy)**
- **Create maps of shared hits between MC->PFO**
- **Select the best match (best completeness)**
- **Make plots only for good matches (>50% purity, >10% completeness)**
- **Make plots for PFOs (PFParticles) regardless of their track/shower label**

Then calculations:

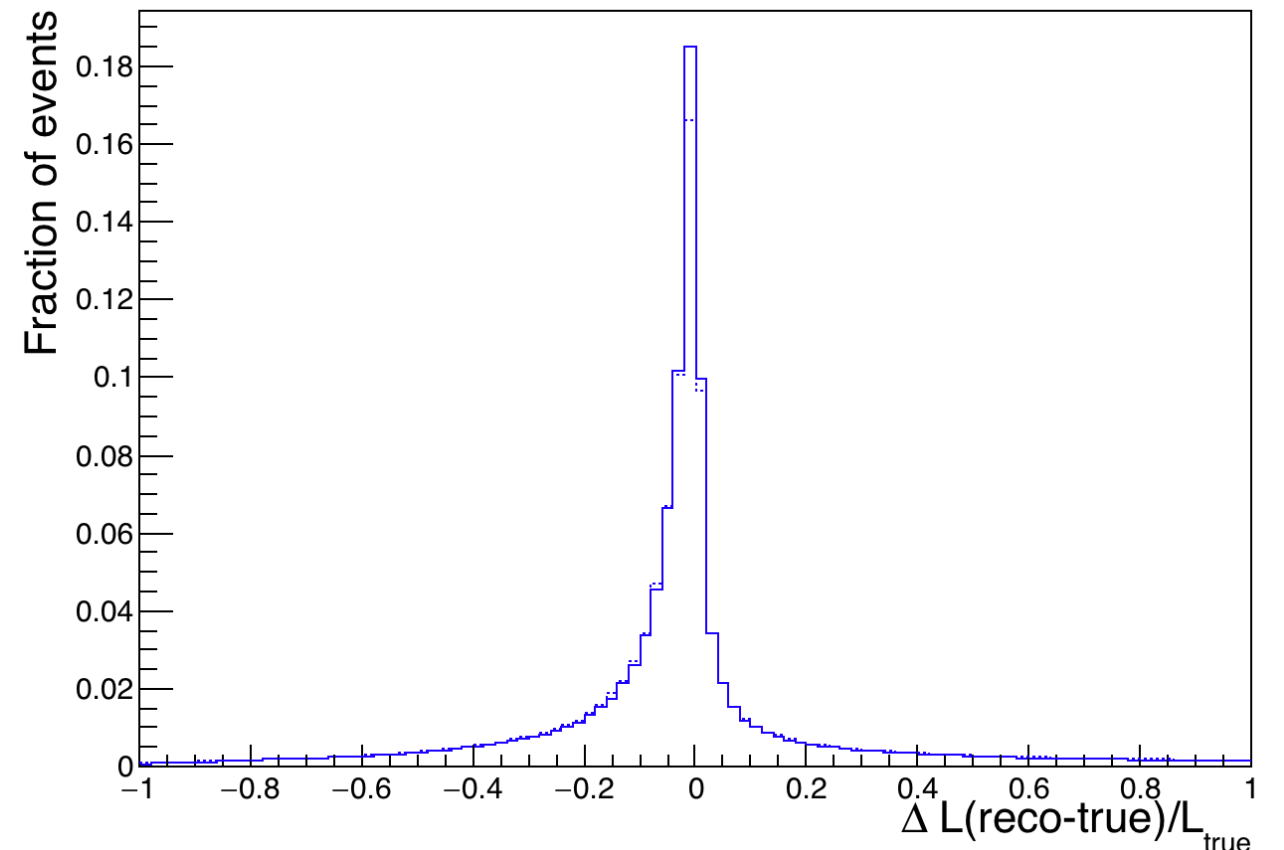
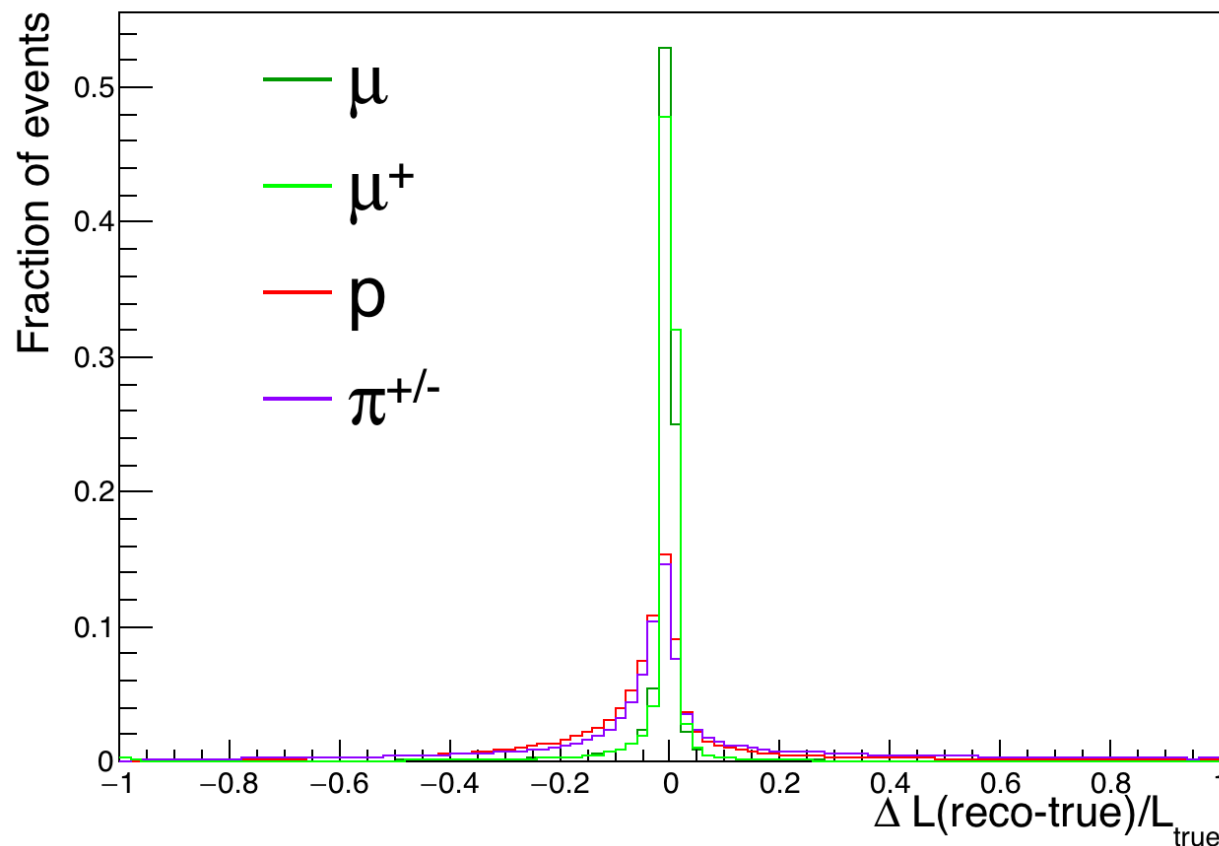
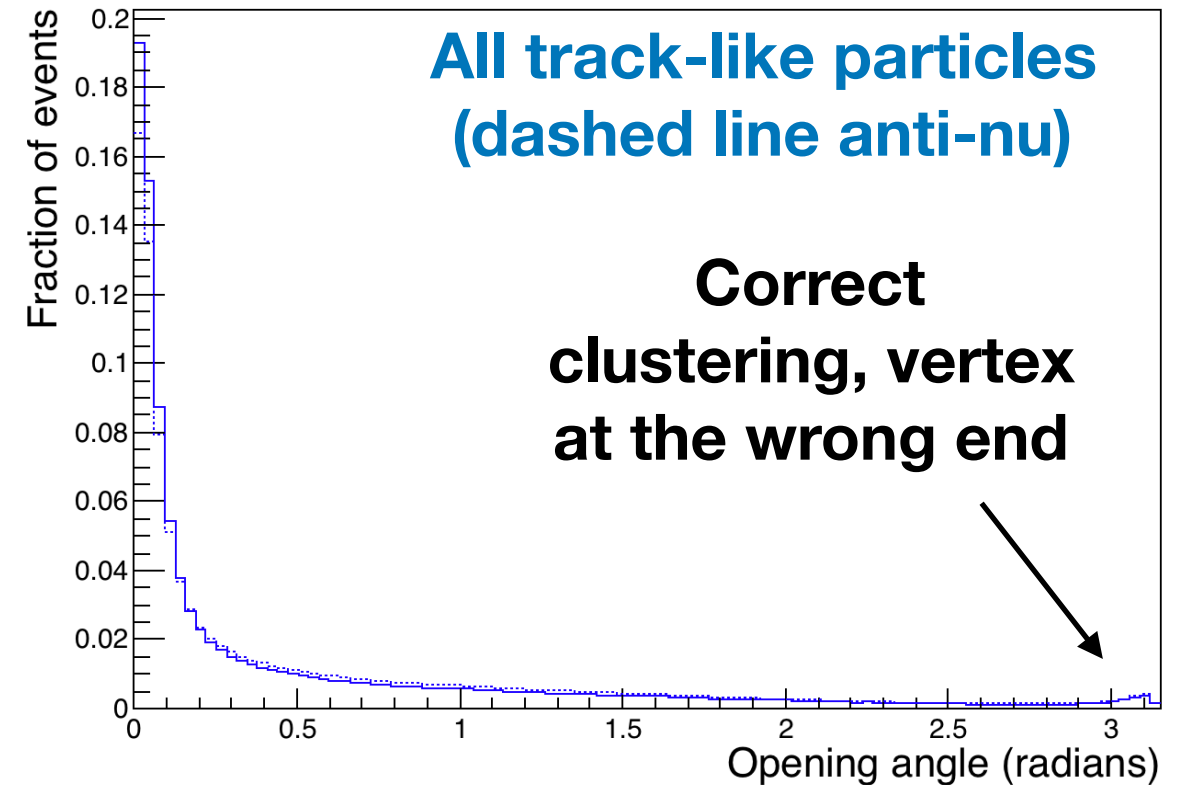
- **Lengths are computed as the module of the vector between start and end points**
- **Opening angle is calculated with the reconstructed and true direction (from true momentum)**



High level reconstruction: Tracks

For track-like MC primary particles:

- Applying containment (both true start and end points within fiducial volume) - see backup for studies about its impact
- No minimum true length required - but could be studied
- Played with 2D plots for track length, could be added as well.



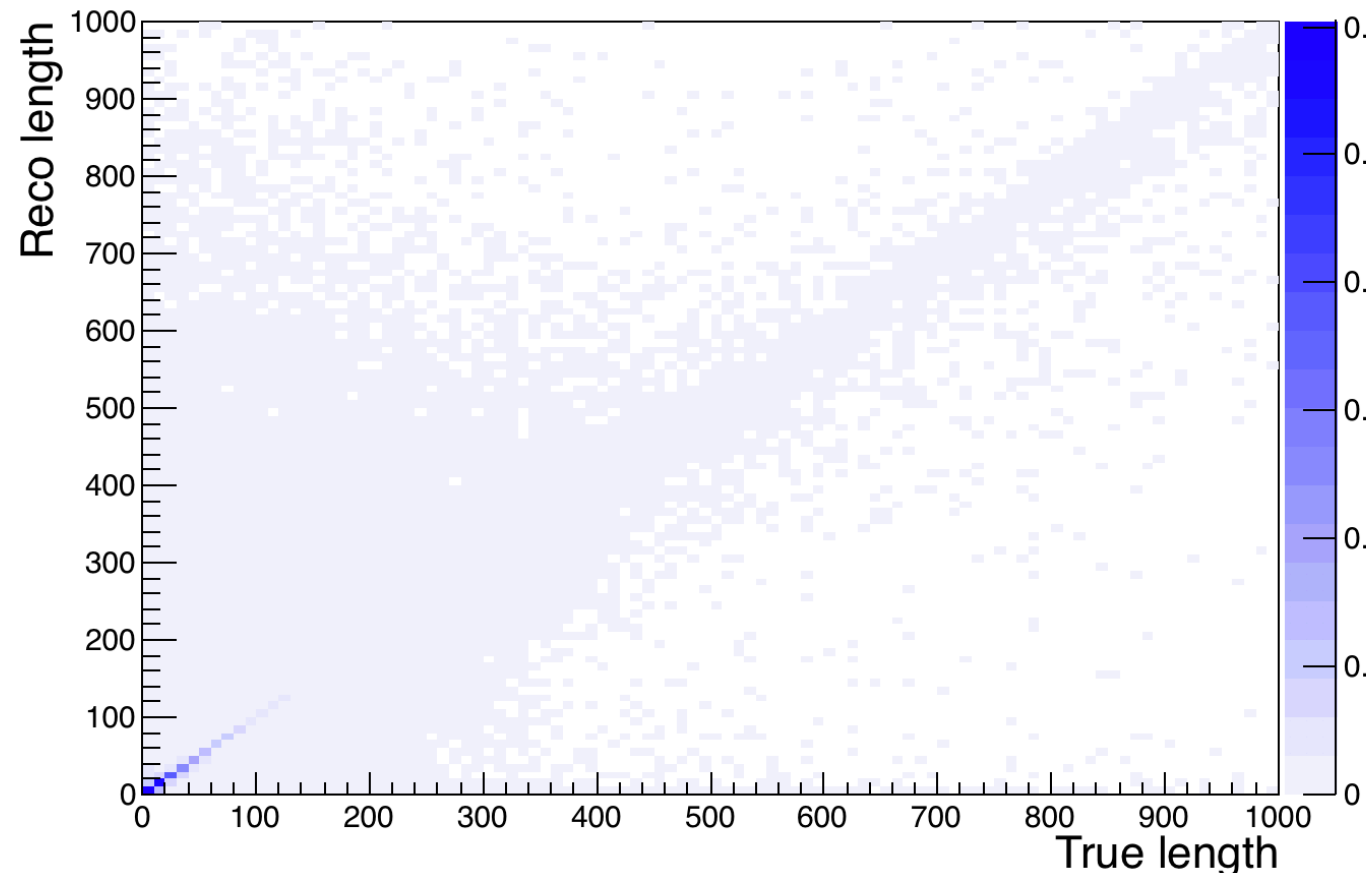
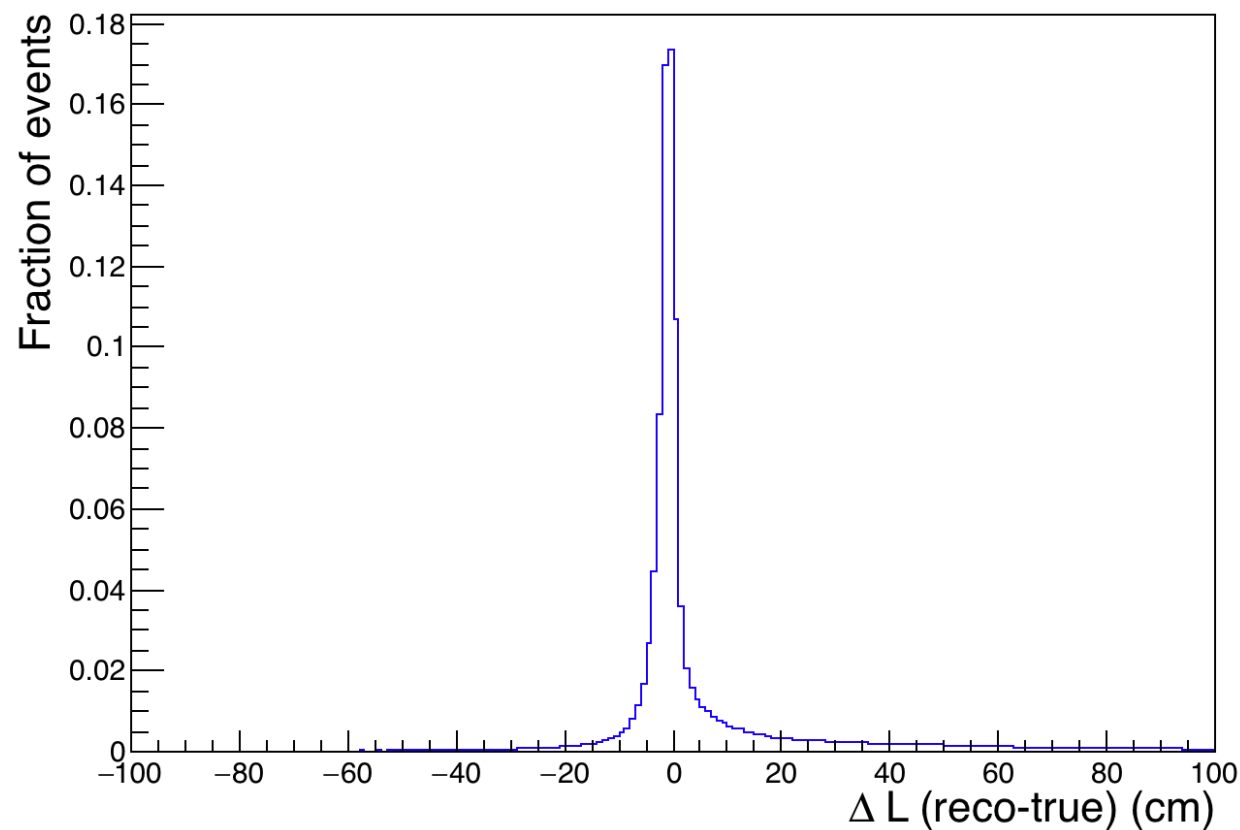


High level reconstruction: Tracks

For track-like MC primary particles:

- Applying containment (both true start and end points within fiducial volume) - see backup for studies about its impact
- No minimum true length required - but could be studied
- Played with 2D plots for track length, could be added as well.
- Ratio or no ratio?

Also, need to quantify in the text:
E.g. X% have a difference in length less than Y cm



Maybe the plot on the right with particle breakdown, and the right with all?



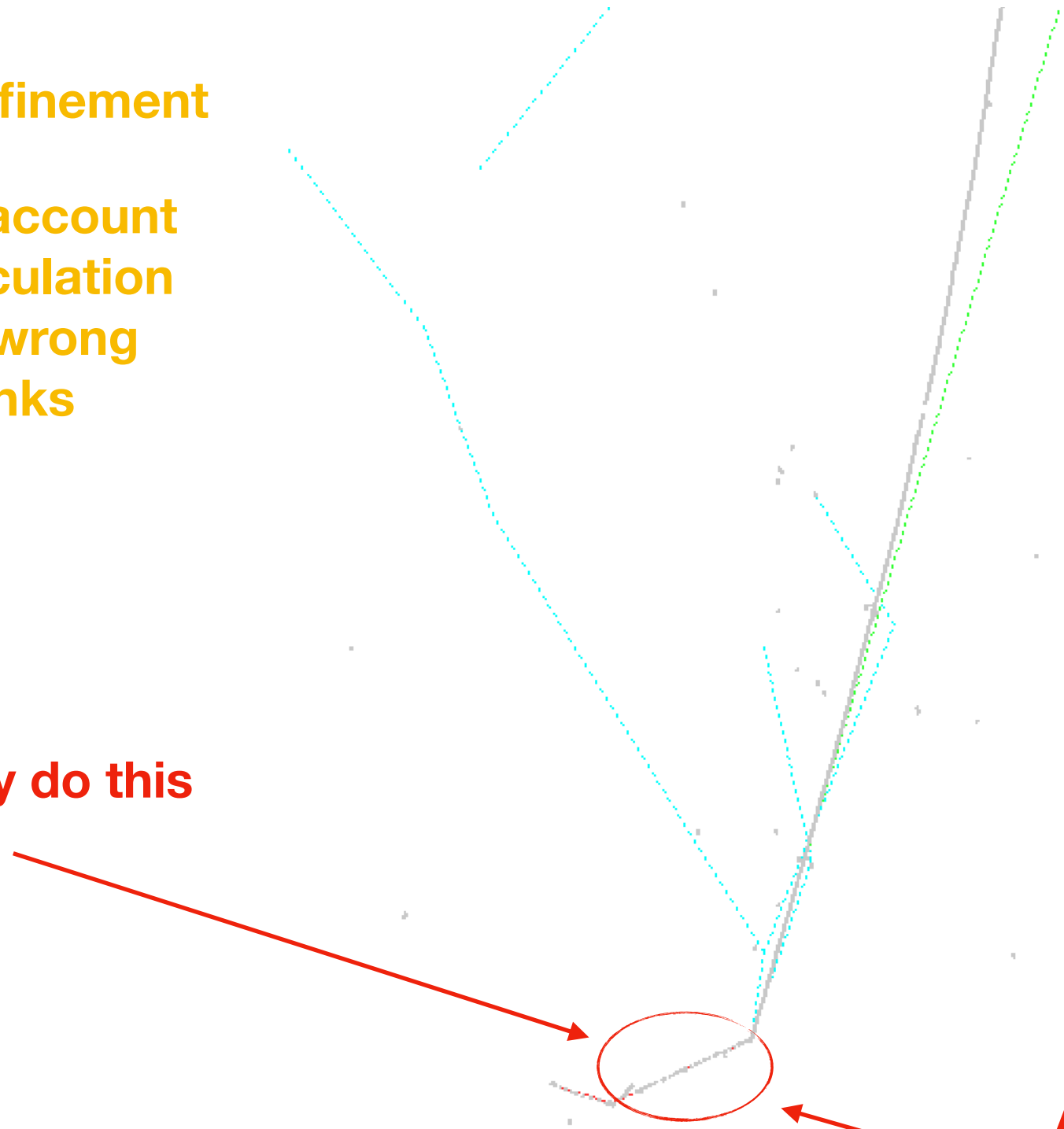
High level reconstruction: Tracks

Plots look good but more investigation is needed for pions/protons

DAUGHTER PFOs - refinement

I am not taking into account daughters in the calculation of length, to avoid wrong results due to kinks

Pions typically do this



And we only want this part



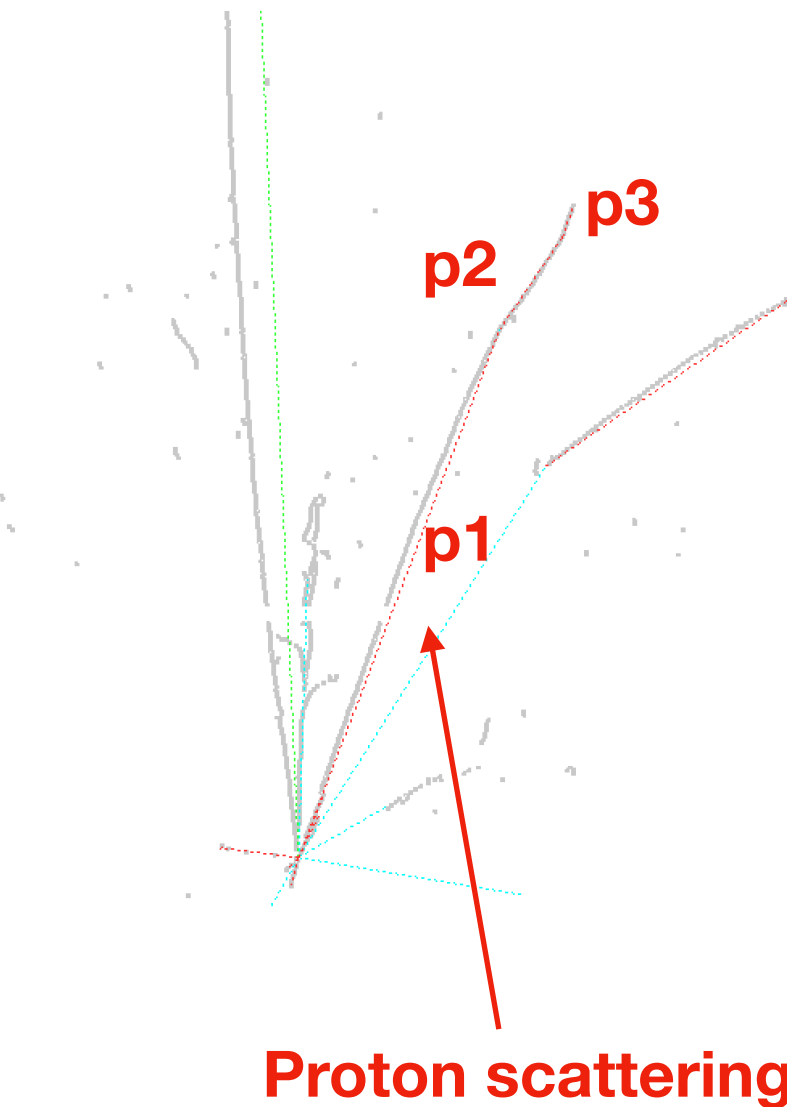
High level reconstruction: Tracks

Plots look good but more investigation is needed for pions/protons

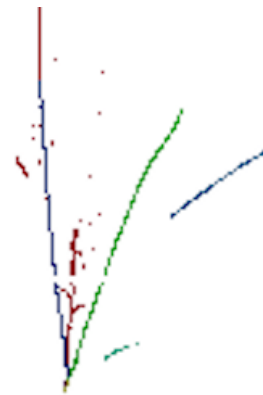
DAUGHTER PFOs - refinement

But sometimes we need to account for scattering

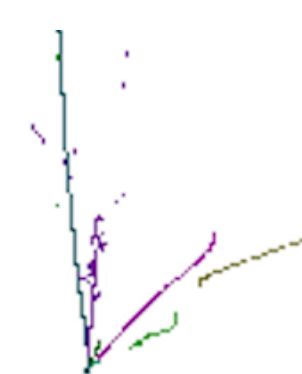
The “scattered stages” (p2 and p3) are different MC particles, so the true length is just the one of p1
But in reality, they look like a single particle:



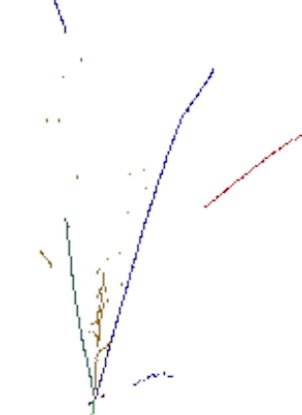
U view



V view



W view



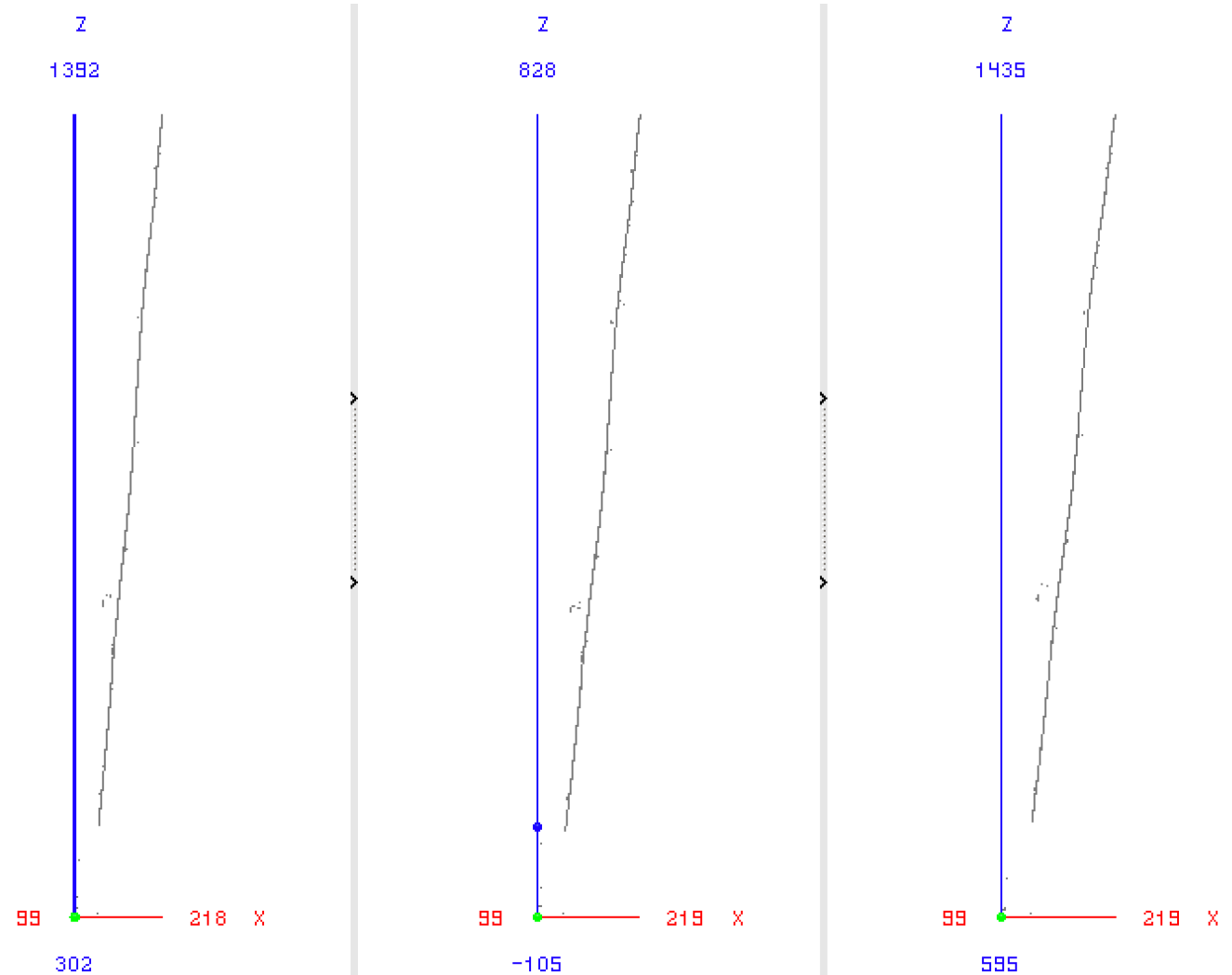
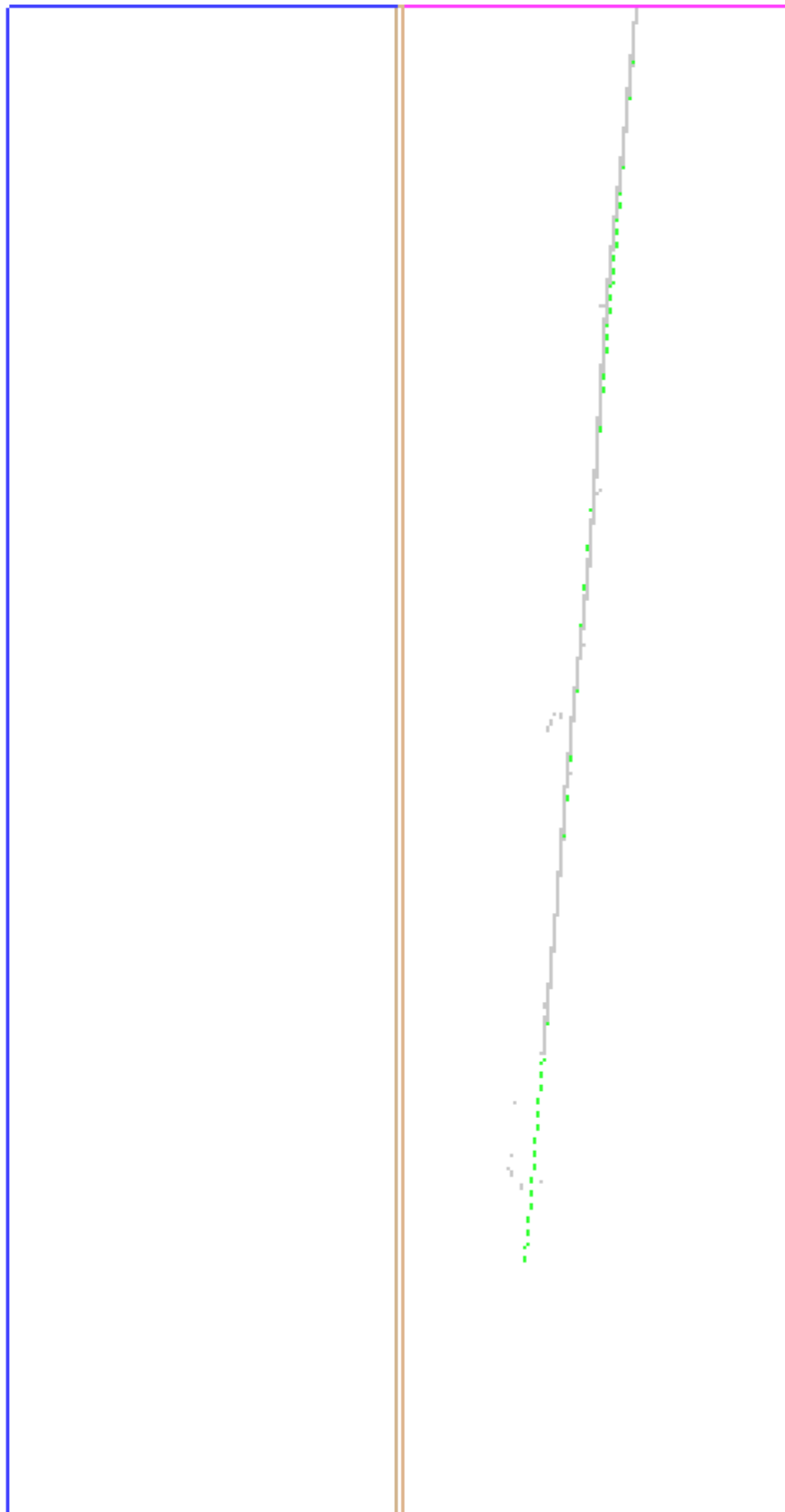
So we can add up length of daughters if the scattering angle is negligible. This will improve especially protons' distribution



High level reconstruction: Tracks

Curiosity...

Looking at cases with large difference in length (reco-true) I found a muon in a CCQEL event with nothing else, >1m long, that travels ~50cm before creating any hits - Why???



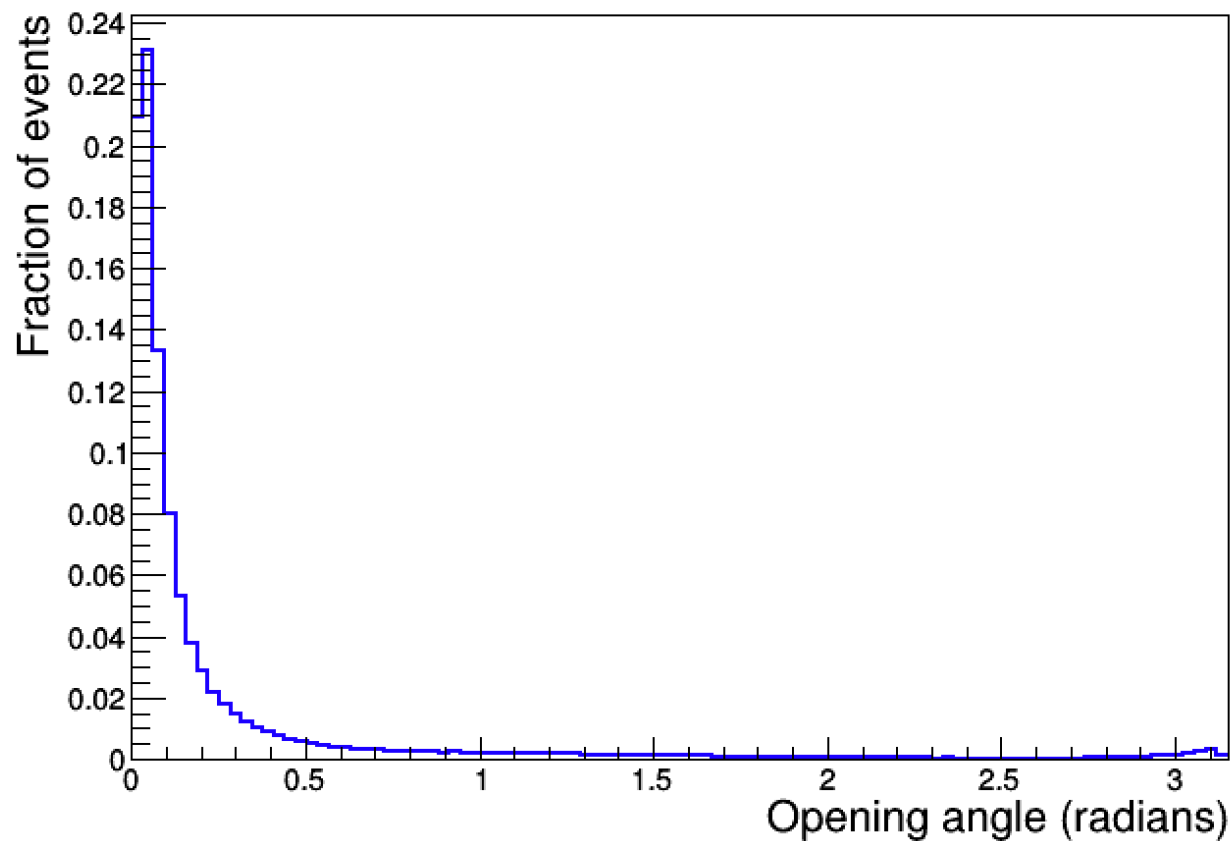


High level reconstruction: Showers

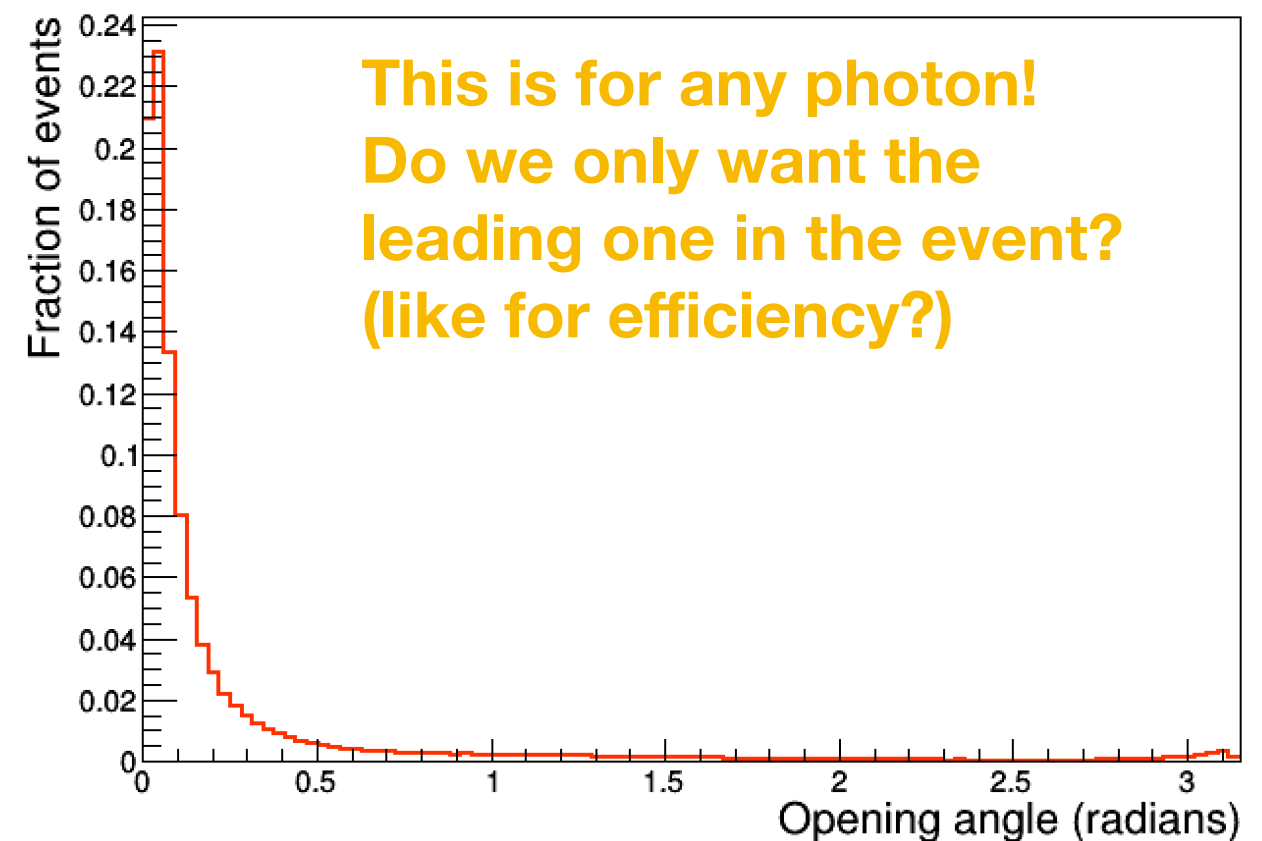
For shower-like MC primary particles: Matching as described in page 11

Shower direction is computed using using PCA as it is used to create the `recob::Shower` objects in `larpandora`

ELECTRONS



PHOTONS



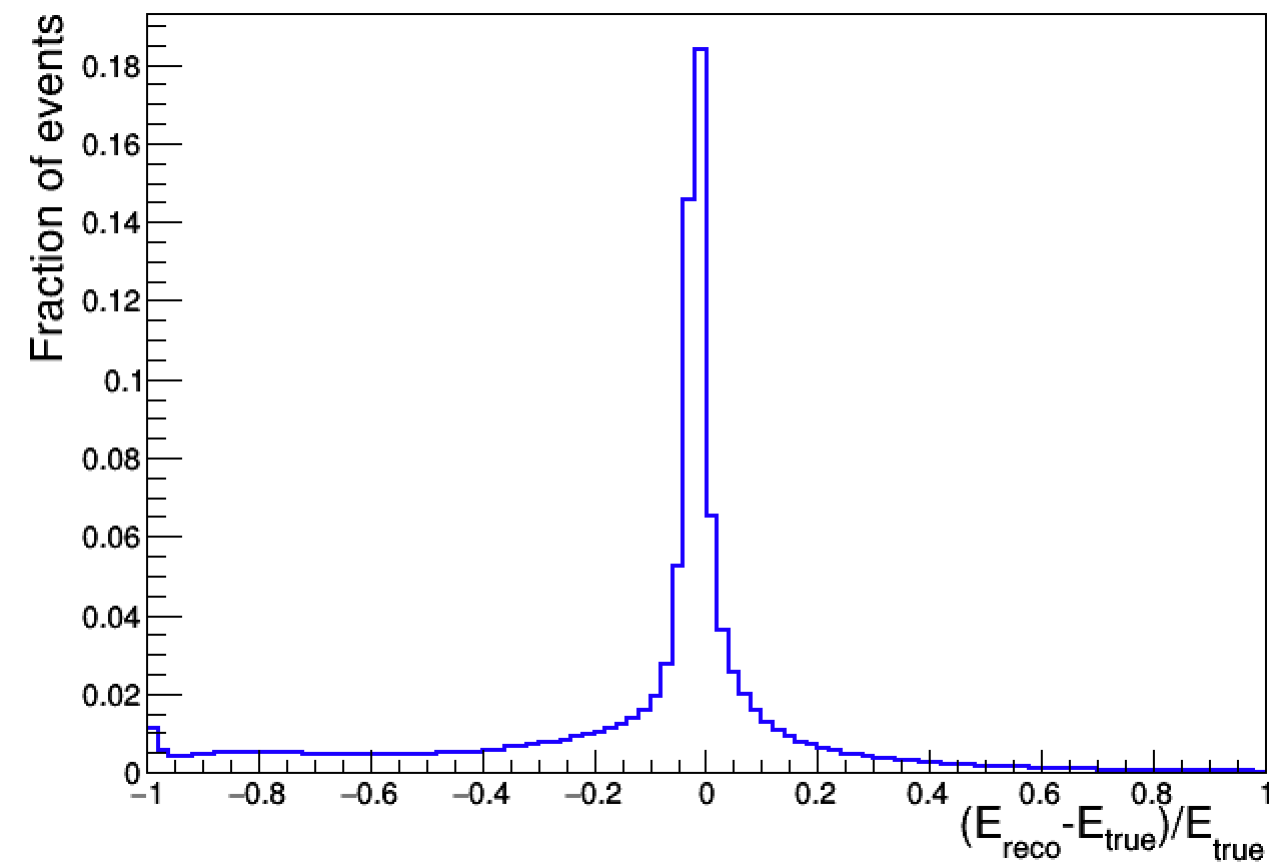


High level reconstruction: Showers

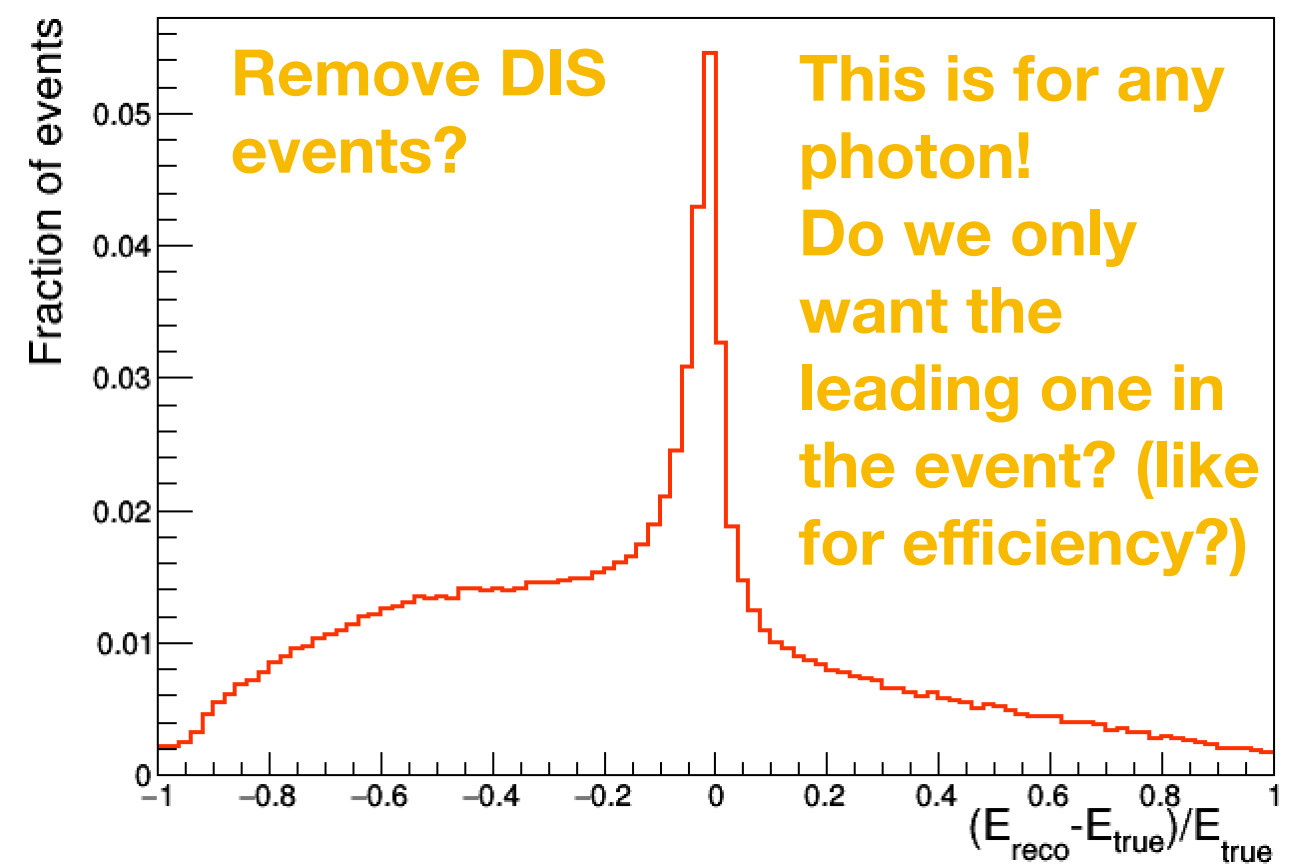
For shower-like MC primary particles: Matching as described in page 11

- Energy is computed using the same methods as in larreco/Calorimetry/LinearEnergyAlg
- Presented only for the collection plane here
- To account for true deposited energy: I am adding the energy of all hits matched to the MC particle (min 90% contribution)

ELECTRONS



PHOTONS

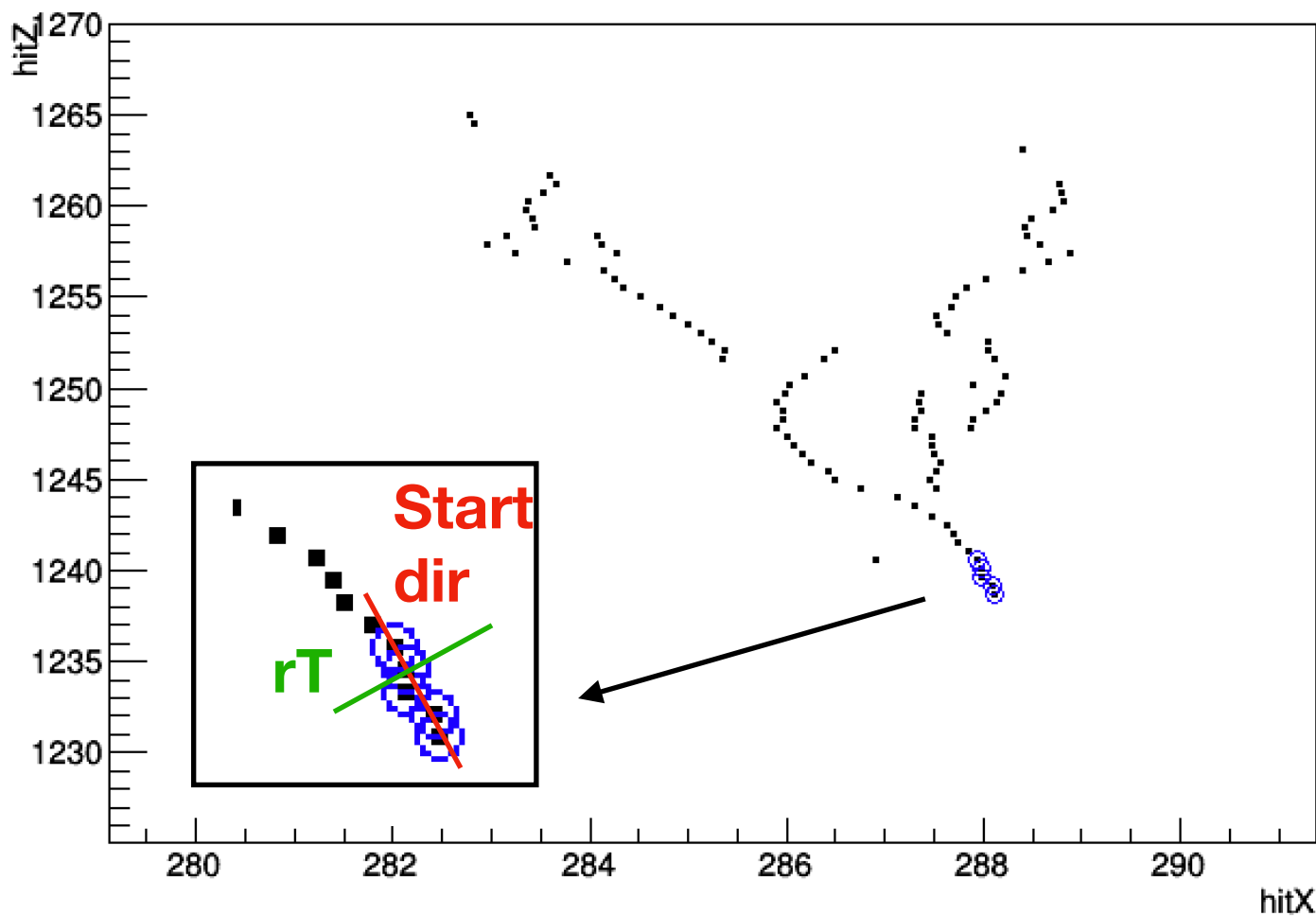


How interesting is this? It is a translation of the completeness provided in page 6



High level reconstruction: Showers

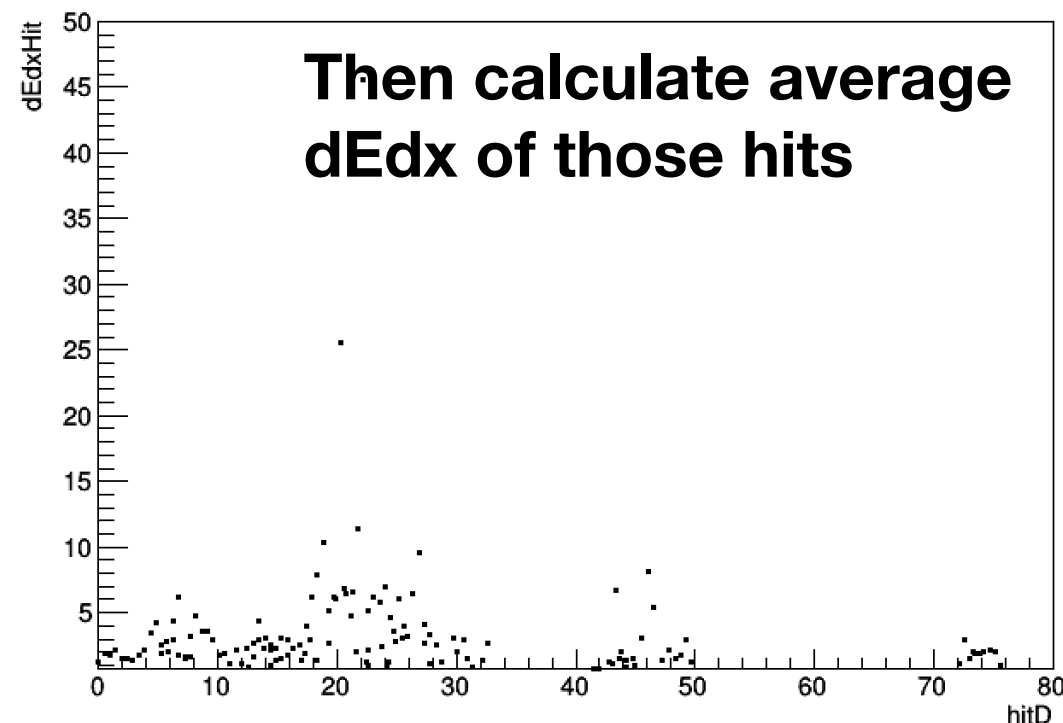
dEdx:



- True start point of the shower within FV
- Plots made only for collection plane (done for other planes in the past), requiring at least 30 hits in that plane
- Explored removing DIS events, as they are very busy, subject to accidental merges

Graphically

- If the MC particle has more than one good match PFO associated (split) use the one closer to the true start point, rather than best match
- Select all hits within 2 cm of the reco shower vertex (projected, found closest hit in each view) BUT
- Select a minimum of X (5) hits
- A cut in rT has also been studied (0.5 cm) but doesn't change much





High level reconstruction: Showers

dEdx:

Technically

- I first started developing this analysis in larpandora (repository that serves as translation between Pandora and LArSoft) in the module that creates recob::Showers (previous presentations)
- This means I started doing this directly in LArSoft and it is painfully slow
- So I moved the logic to an algorithm inside Pandora (LArContent) - way faster, and I can handle the true-reco matching logic in the same way as inside Pandora
- Both ways (entirely in Pandora or entirely outside Pandora) need **rewriting code**:

In Pandora

- **ConvertXToTicks** (recover hit time)
- **Methods in CalorimetryAlg**:
 - **LifetimeCorrection**
 - **ModBoxCorrection**

In LArSoft

- **Pandora's Rotational Plugin**
- **Undo breakdown of a single cluster into multiple due to several TPCs**
- **Reco-true matching**

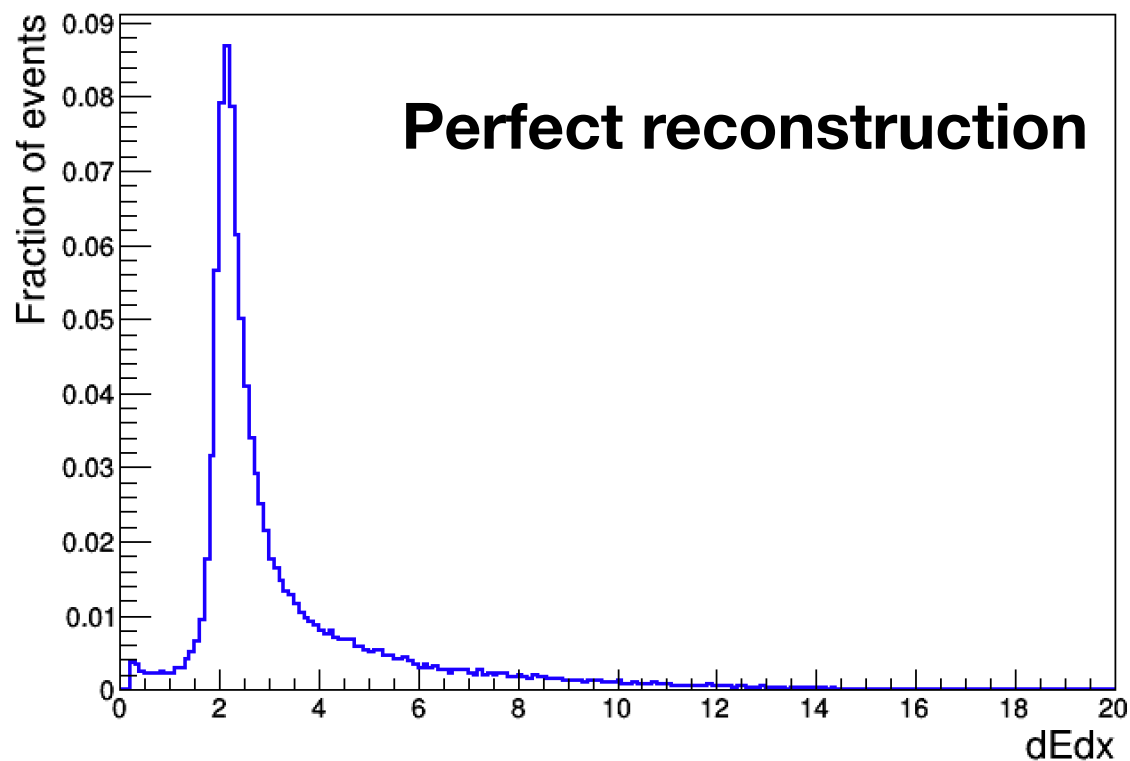
To release this (post-TDR): geometrical logic (selection of hits) will be done inside Pandora and the information transferred (a la LArPfoTrack) to the larpandora module to access the calorimetry methods



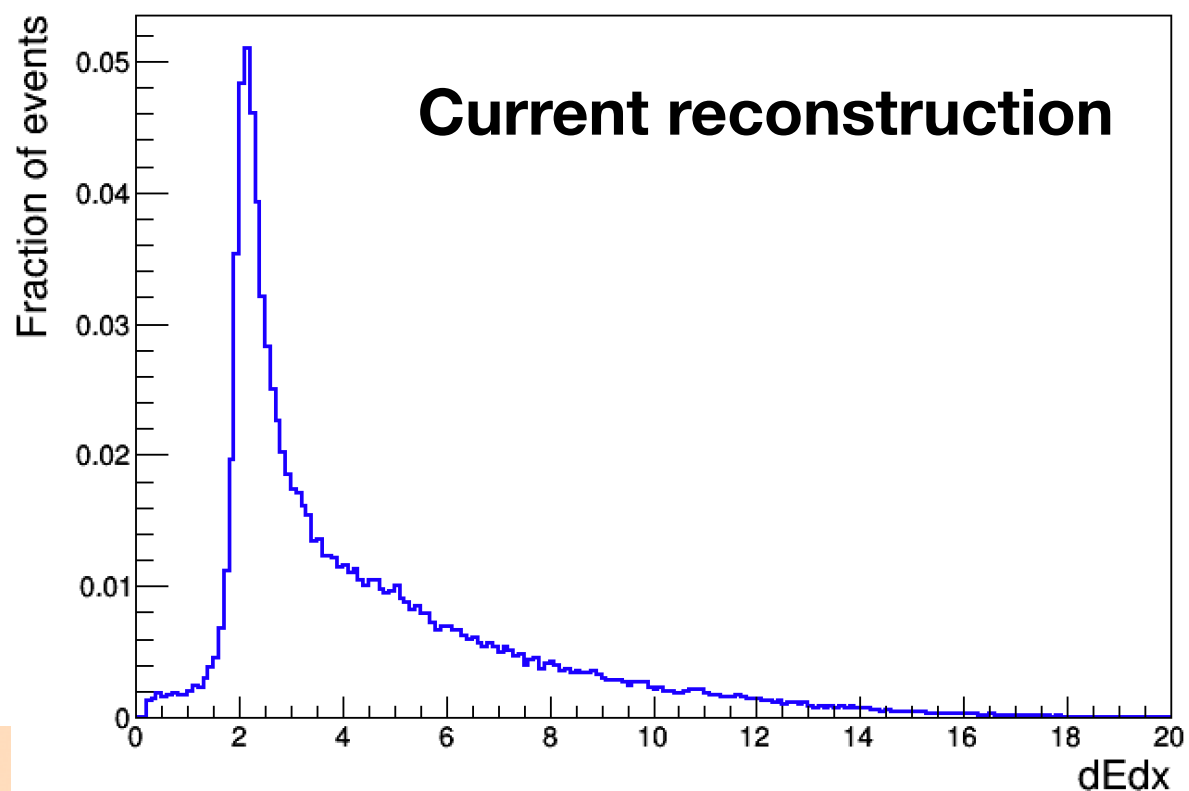
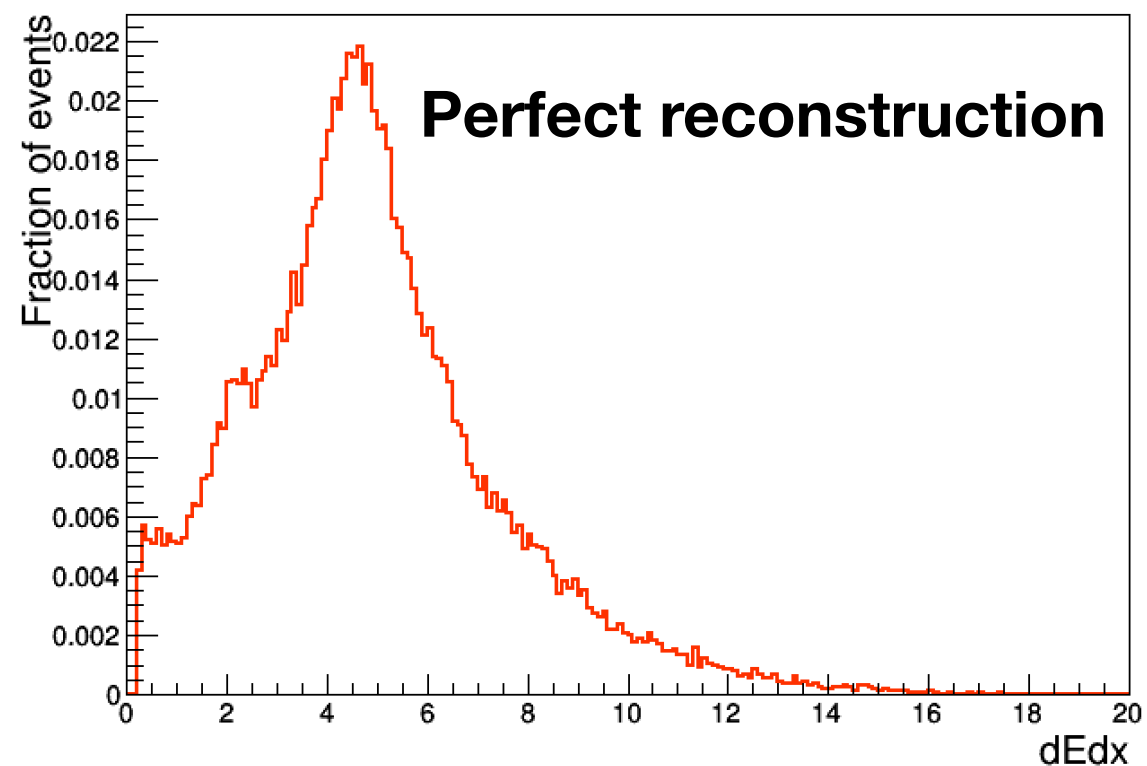
High level reconstruction: Showers

dEdx:

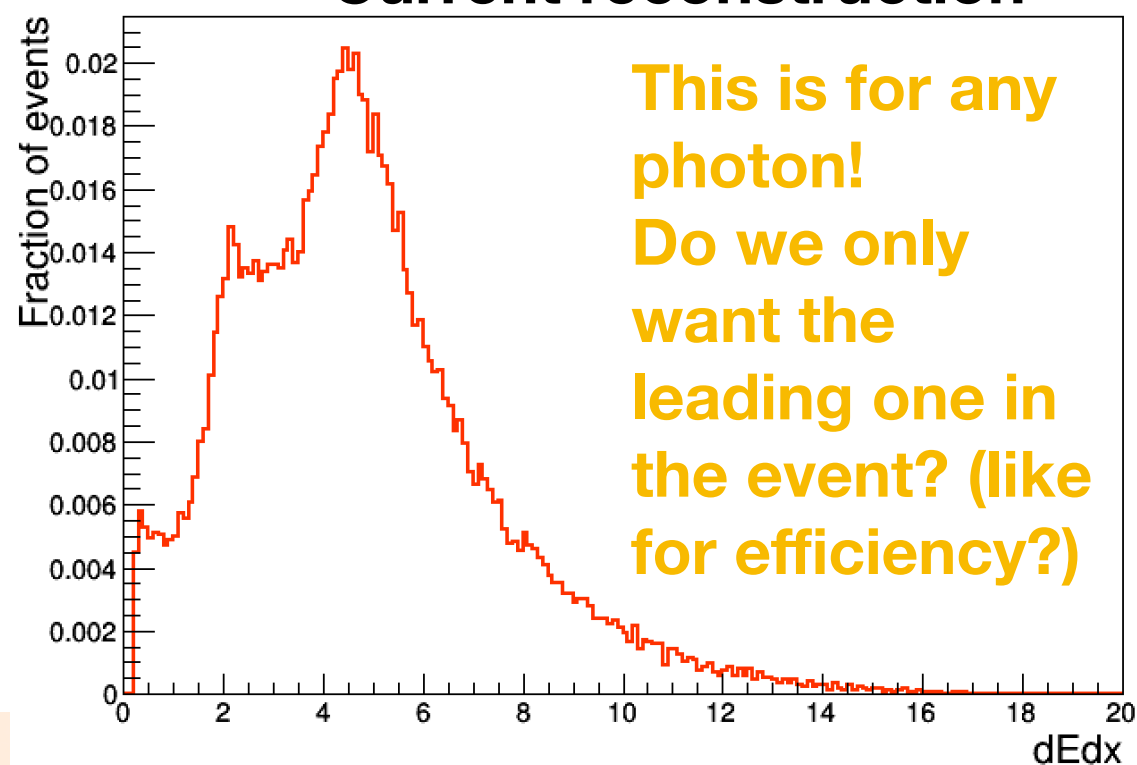
ELECTRONS



PHOTONS



Current reconstruction

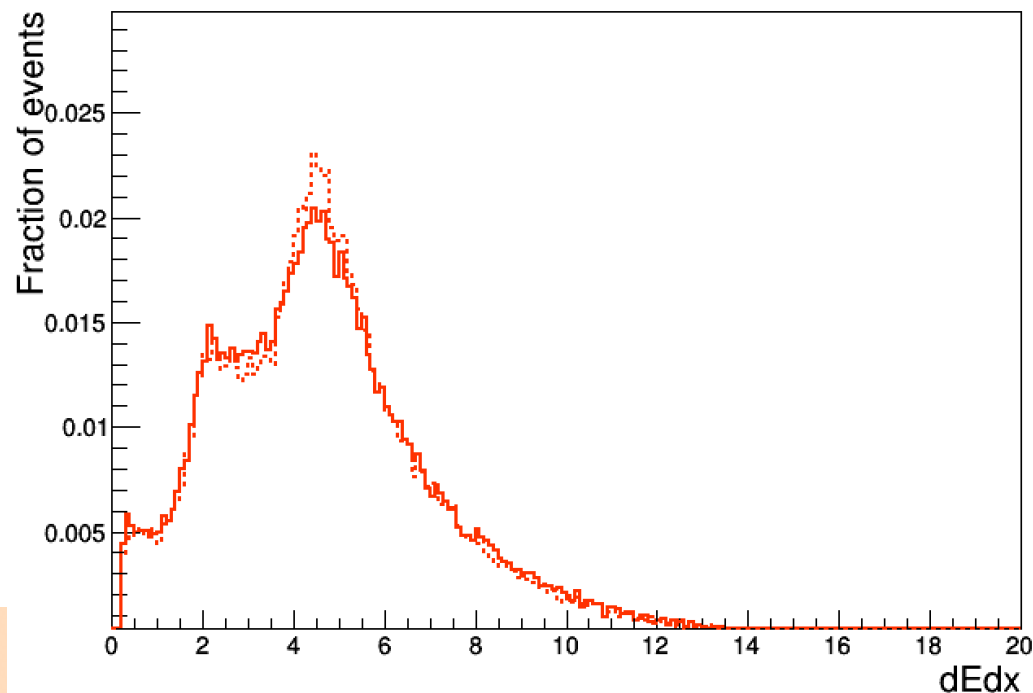
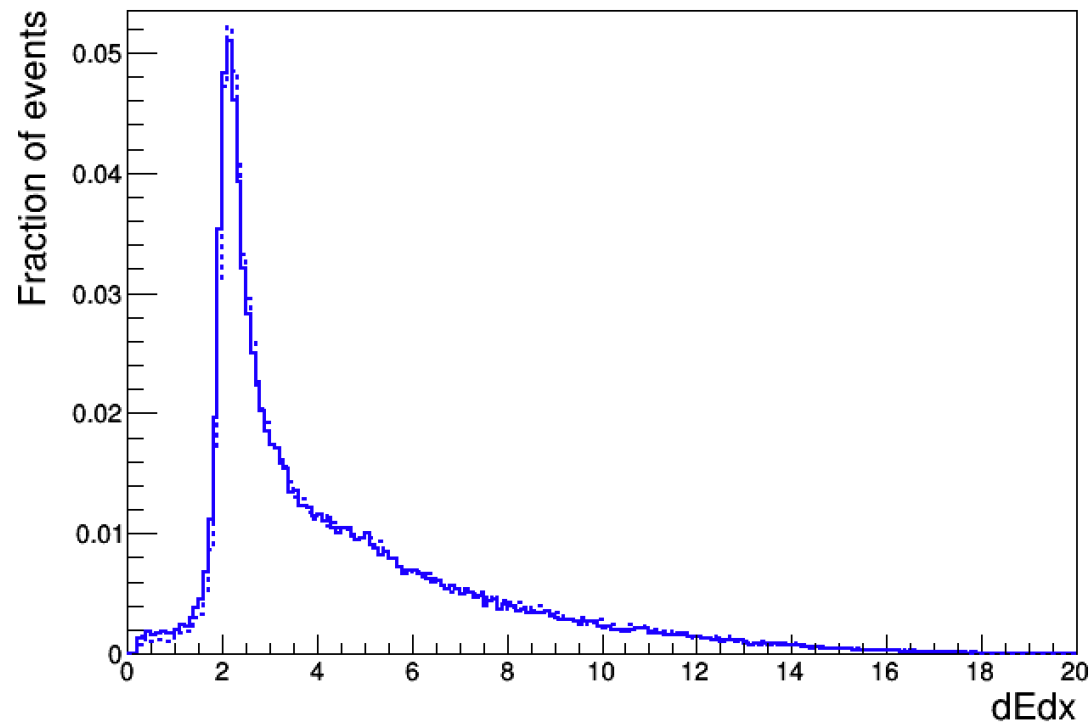




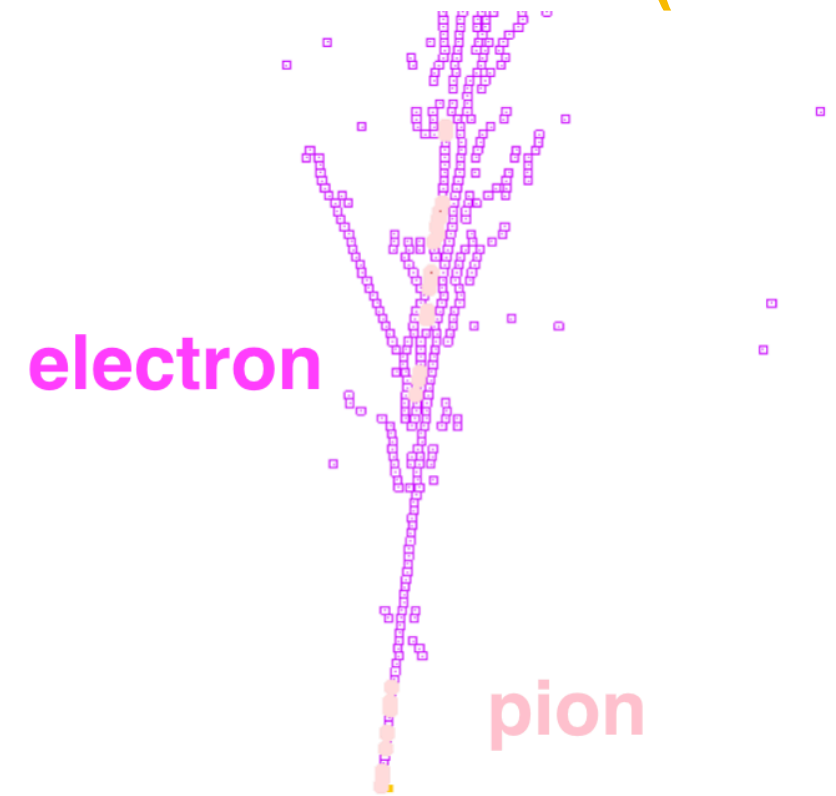
High level reconstruction: Showers

dEdx investigation (ongoing)

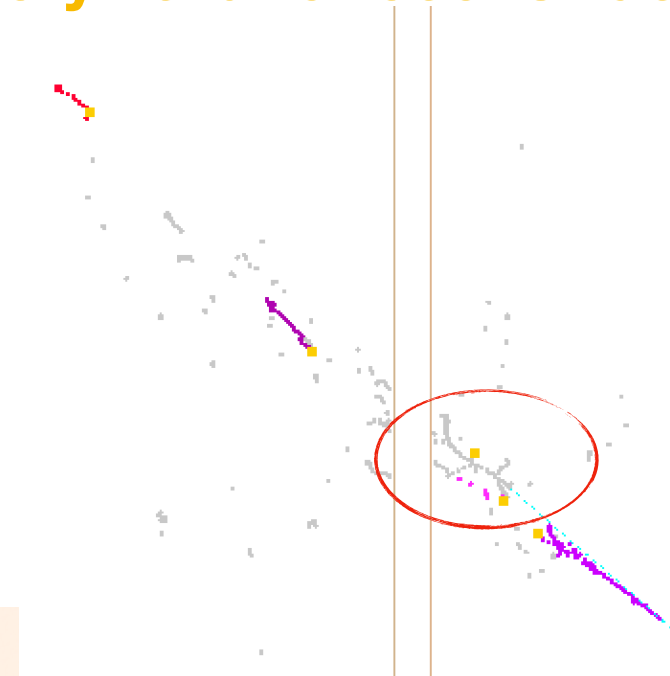
Using the true direction (dashed lines) doesn't have a big impact



Sometimes there is contamination (unavoidable)



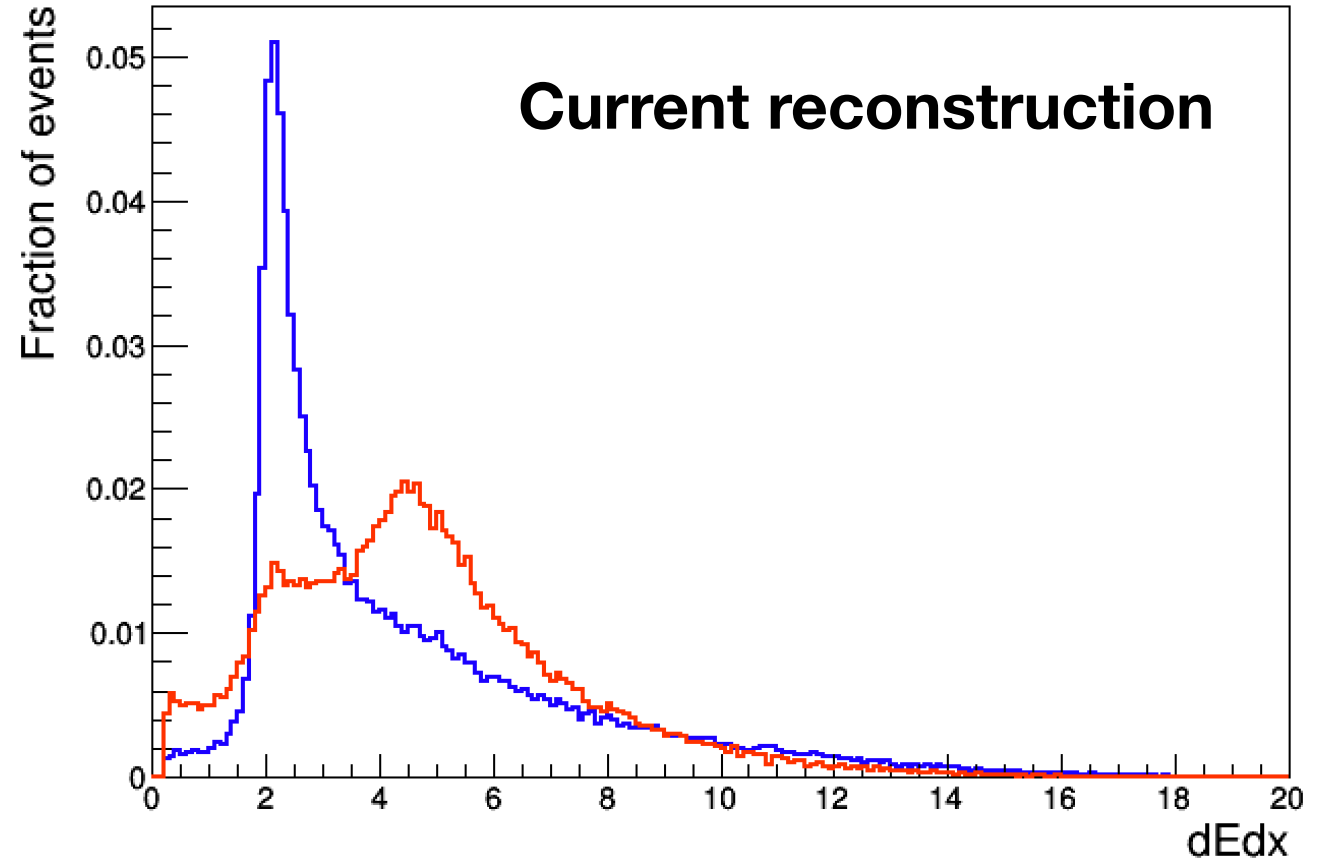
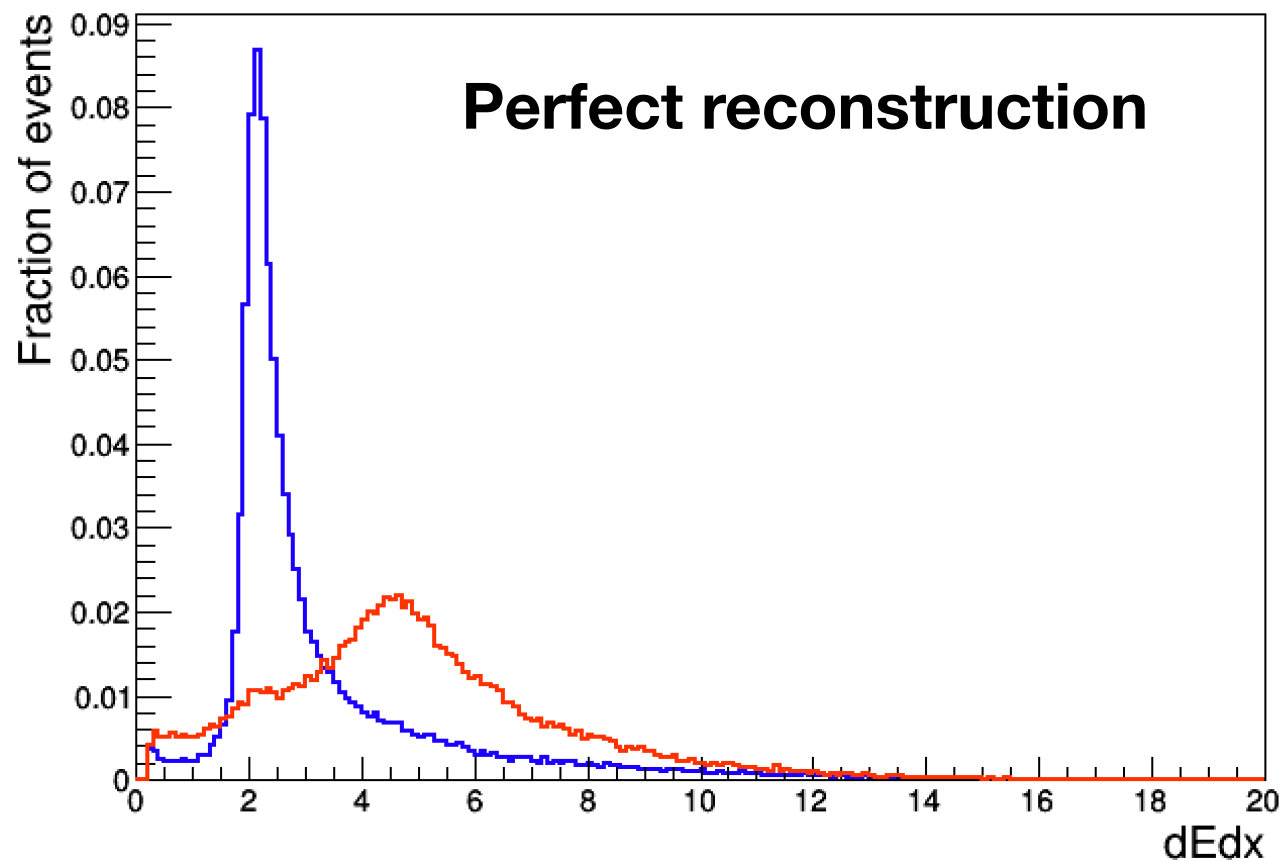
Sometimes I've seen it's related to the vertex reconstruction (improvements expected), sometimes very hard to reconstruct well:





High level reconstruction: Showers

electron/gamma separation: moving forwards



There are other features we can use to separate electron/photon

- Point shower starts showering
- Distance shower vertex to neutrino vertex

I would like to try using them as a continuation of this study, but what do we want for the TDR?

Also, Jhanzeb, PhD student working with John in Warwick, has developed already a SVM model for vertex selection in DUNE FD, which I am going to try - that I expect to make an impact in these plots!



Summary

- Updated and created plots according to the TO-DO list for the TDR
- Some plots need a bit of discussion/ investigation
- Then text in overleaf also needs to be updated
- For end of April?



Contact us

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ProtoDUNE Integration

Steven Green (sg568@hep.phy.cam.ac.uk)

MicroBooNE Integration

Andy Smith (asmith@hep.phy.cam.ac.uk)

Other team members

MicroBooNE: Joris Jan de Vries, Jack Anthony
ProtoDUNE: Stefano Vergani



<https://github.com/PandoraPFA>



<https://pandorapfa.slack.com>



UNIVERSITY OF
CAMBRIDGE

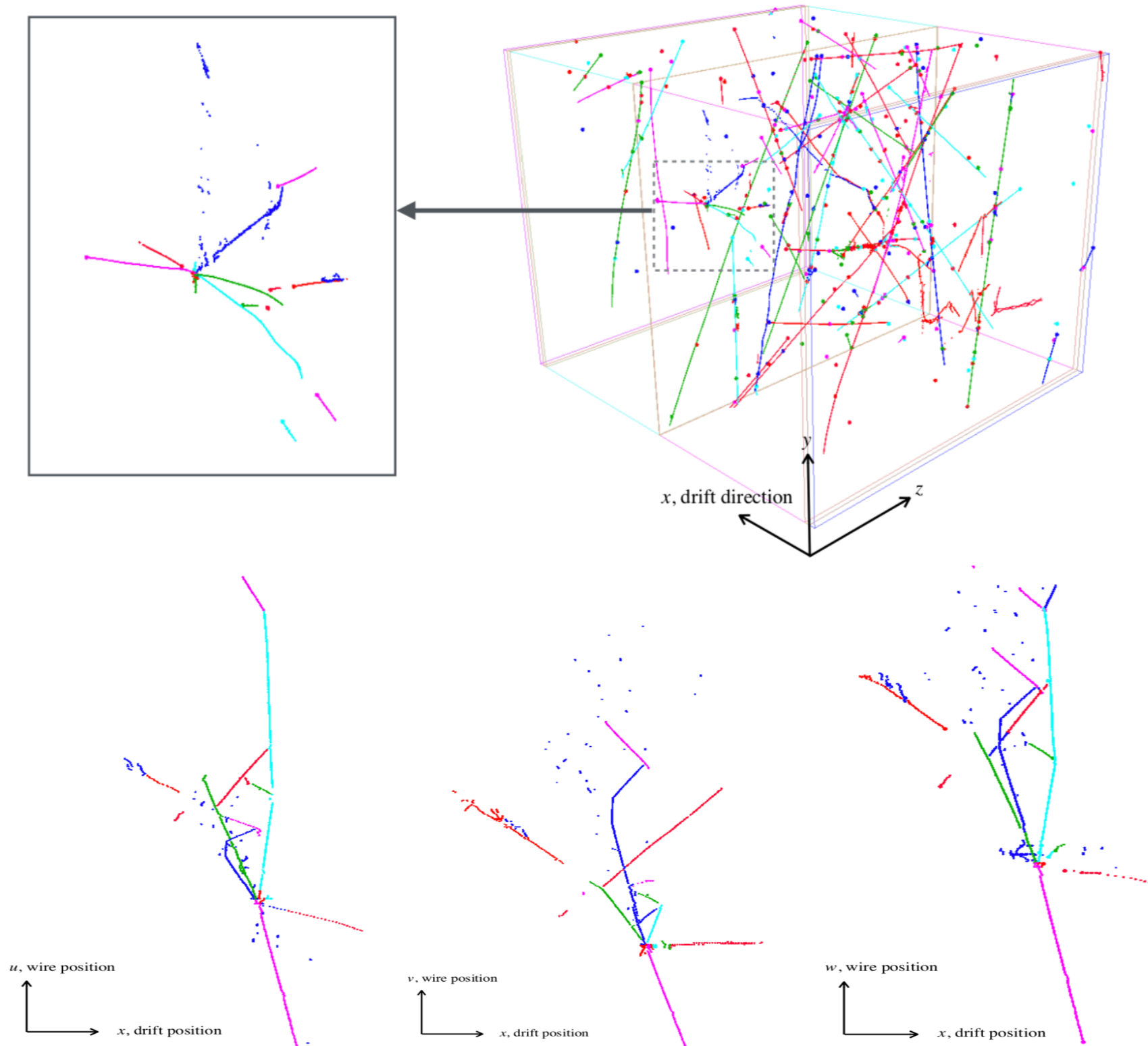
Lancaster
University





Reconstruction Performance

1.3.3 Reconstruction Performance in ProtoDUNE-SP





High level reco: tracks

Plots look good but some refinements are needed

1) Containment (i.e. true start and end position in fiducial volume)

