Reconstruction performance and characterisation of electromagnetic showers in the SBND detector.

Ala Zglam

The University of Sheffield

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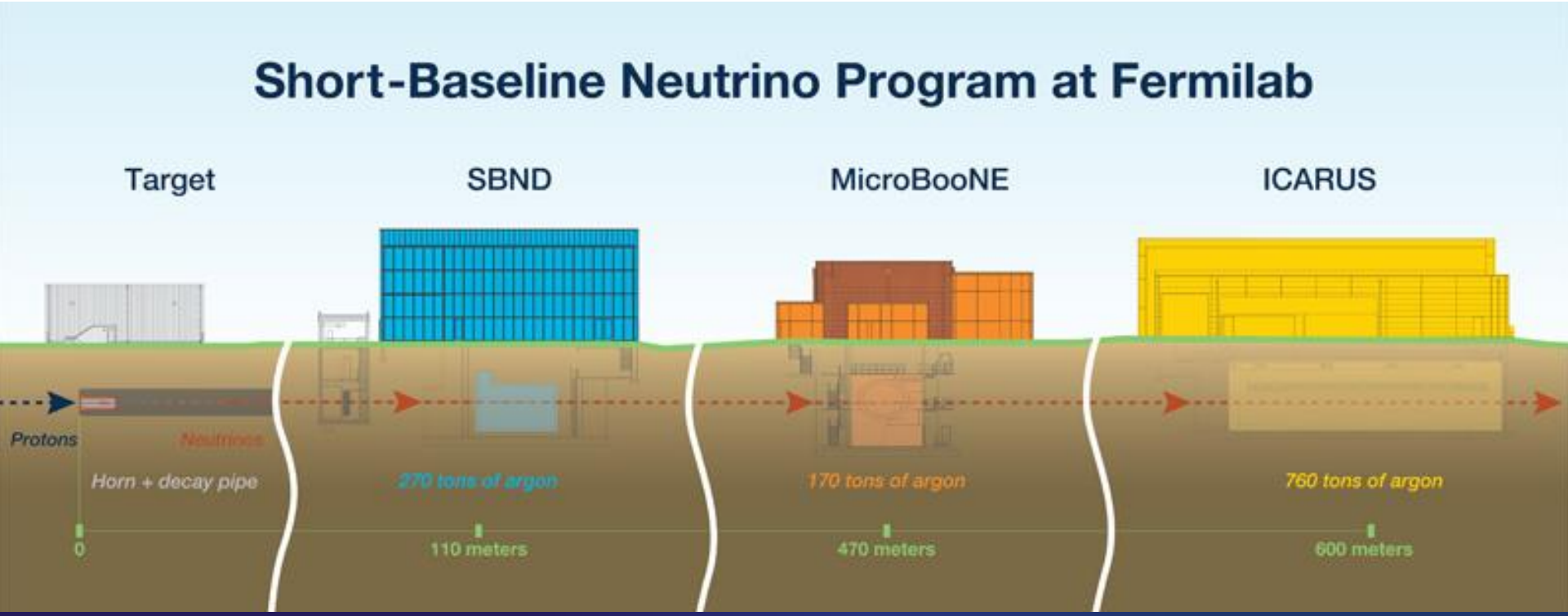
Short-Baseline Near Detector (SBND)

Introduction

- **Short-Baseline Neutrino Program:**
  - **Short-Baseline Near Detector (SBND).**
  - **MicroBooNE.**
  - **Short-Baseline far detector (ICARUS).**
    (Imaging **C**osmic **A**nd **R**are **U**nderground **S**ignals)
- **The SBN program detectors are based on Liquid Argon Time Projection Chambers (LArTPCs) technology.**
- **SBN aims to search the oscillations between neutrinos at a short distance.**
- **A world-leading measurements of neutrino interactions.**

- **Short-Baseline Near Detector (SBND):**
  - **located 110 m from the Booster Neutrino Beam (BNB).**
  - **Closest of the three to the BNB neutrino source.**
  - **An active mass of 112 tons.**
  - **Critical role for sterile neutrino search.**
  - **Outstanding cross-section measurements.**
  - **BSM physics programmes.**
  - **Will start collecting data in mid 2023.**



Short-Baseline Near Detector (SBND)

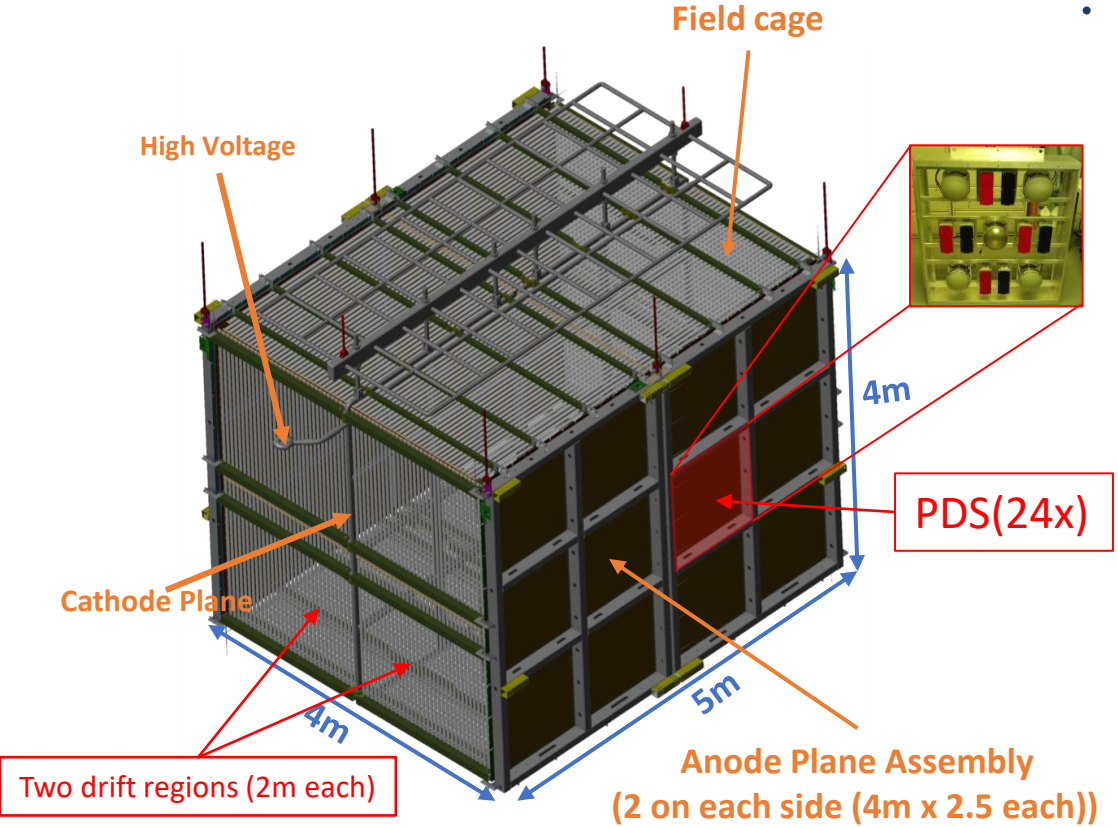
SBND Detector

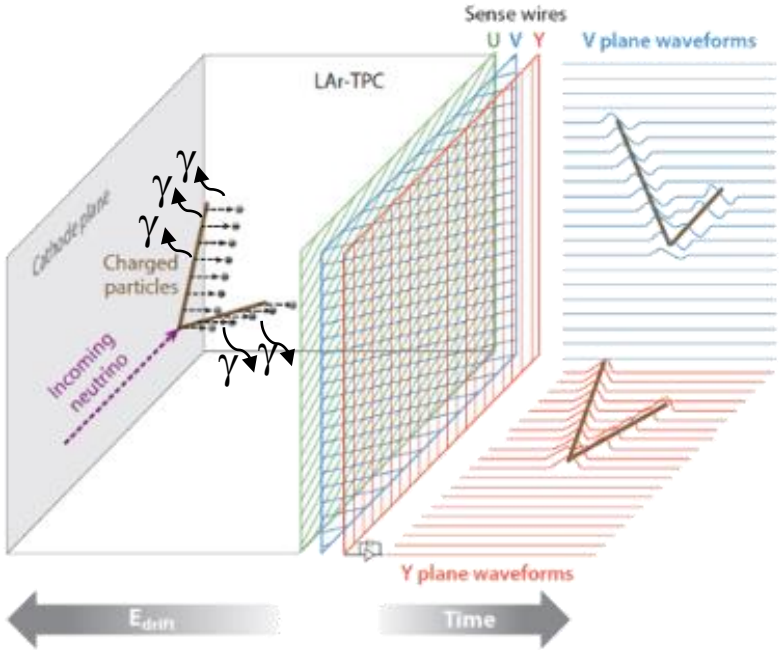
SBND Detector:

- SBND Detector base on LArTPC with active mass of 112 tons.
- Photon Detection System (PDS); 24 detectors distributed on two sides.
- An external system for Cosmic Ray Tagging (CRT).

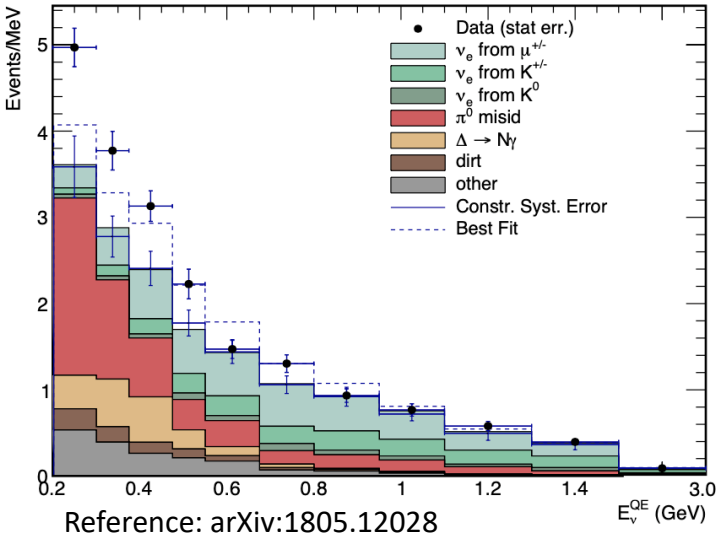
SBND LArTPC design and operation principles:

- Two TPCs separated by a centre cathode plane.
- Two Anode Plane Assemblies (APAs) for each TPC.
- Each APA contains three wire planes.
- Tow induction planes (U and V) at $\pm 60^{o}$ to the vertical(Y).
- A field strengths of 500V/cm applied uniformly between APAs and CPA.
- Ionisation electrons will be drifted to the planes.
- Photons released will be detected by PDS.

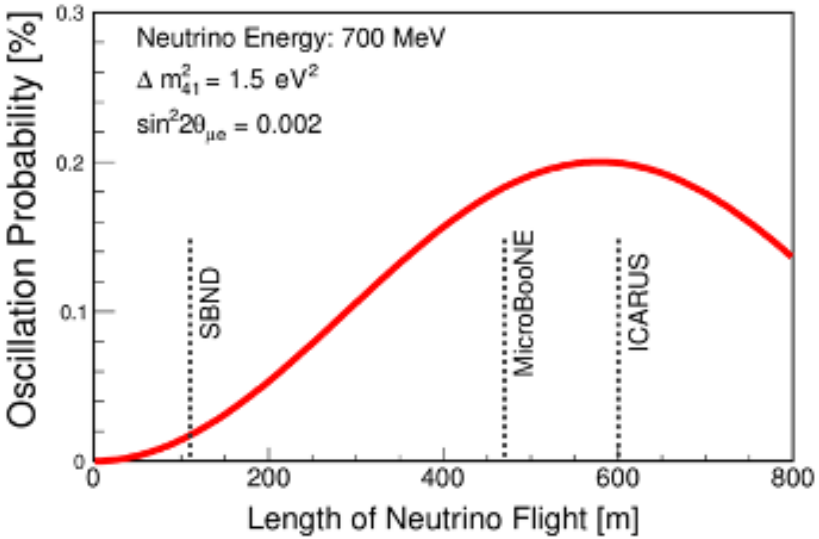




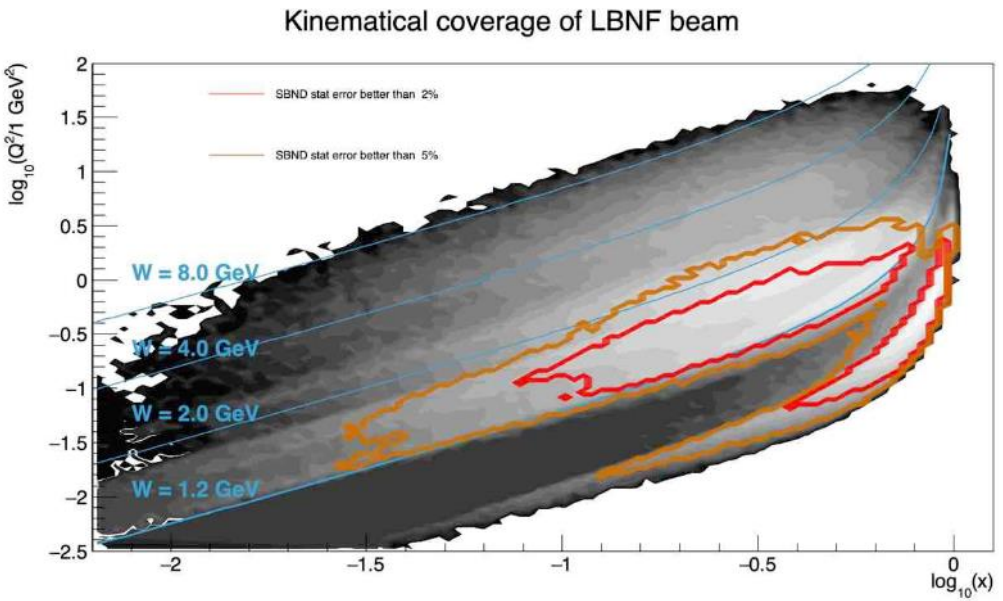
➢ Oscillations search.



Reference: arXiv:1805.12028

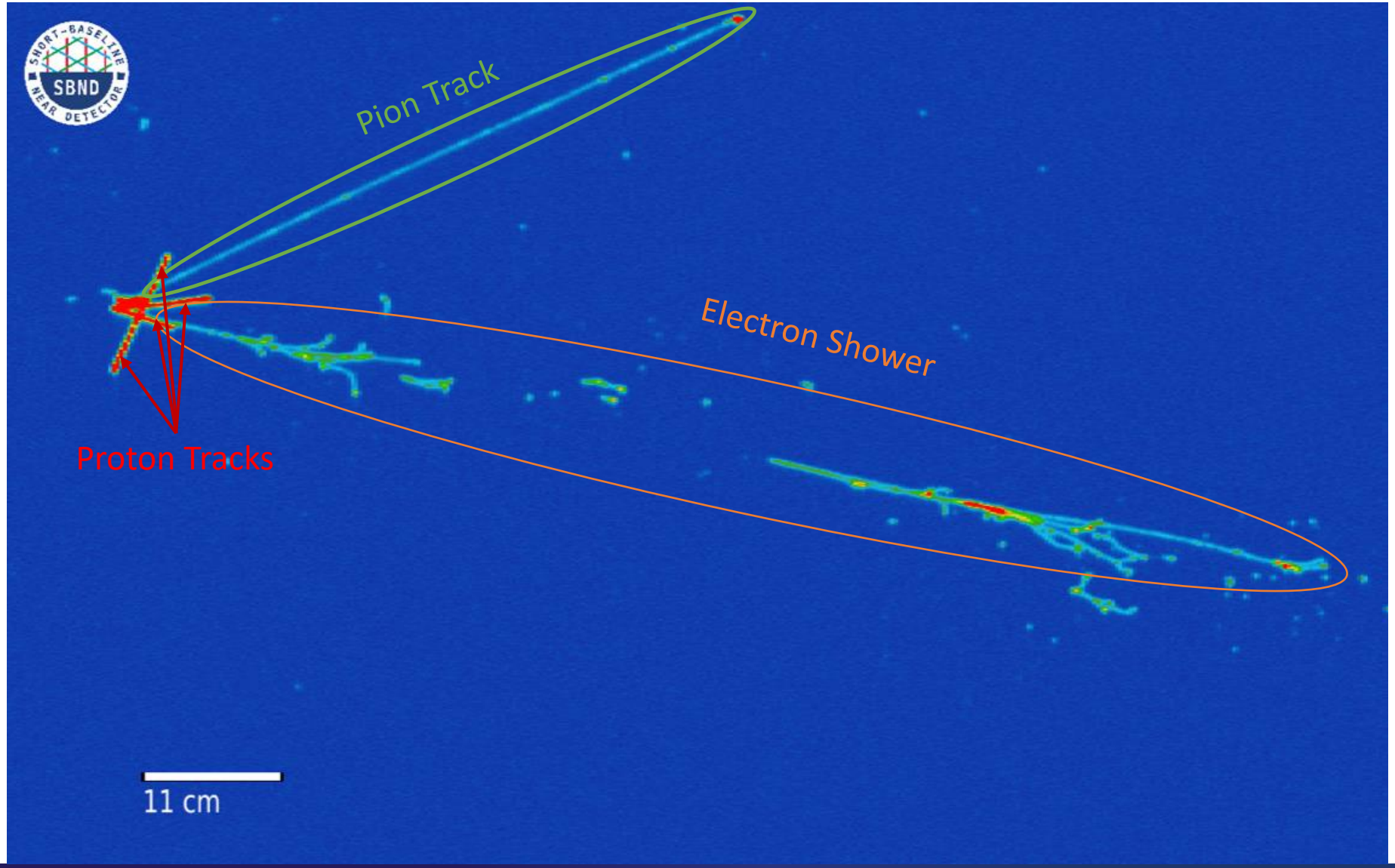


➢ Cross-section measurements.



Short-Baseline Near Detector (SBND)

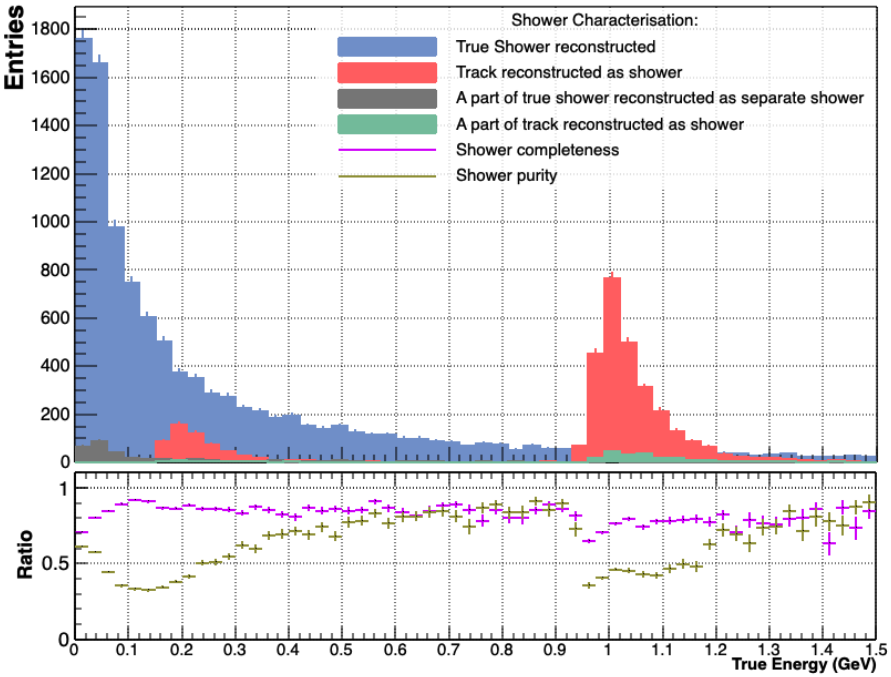
Event Display

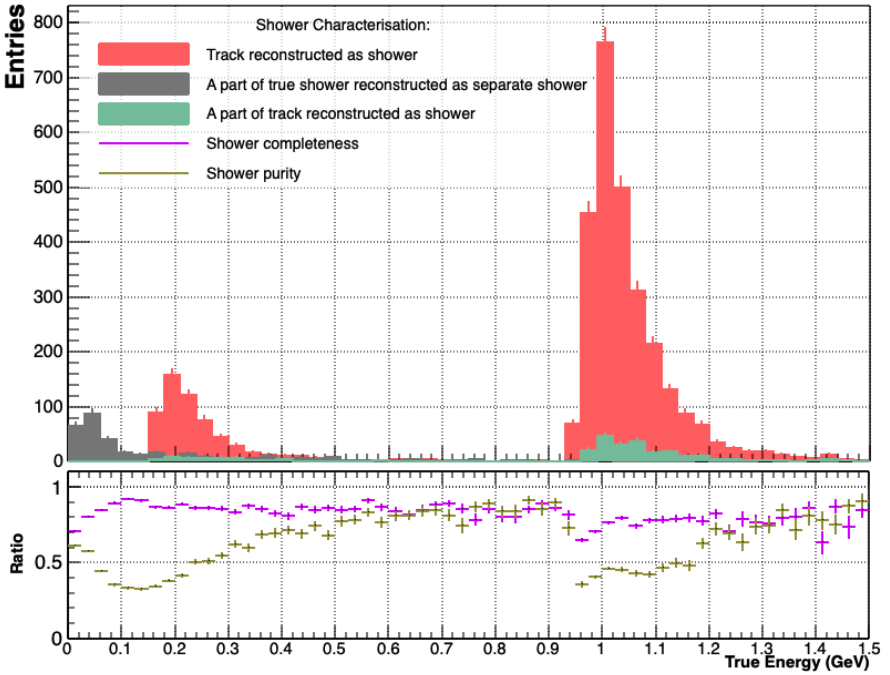


Shower Characterisation

Electron-Neutrino samples (Nu-e)

- **True Particles energy with electron shower characterisation for Nu-e samples.**

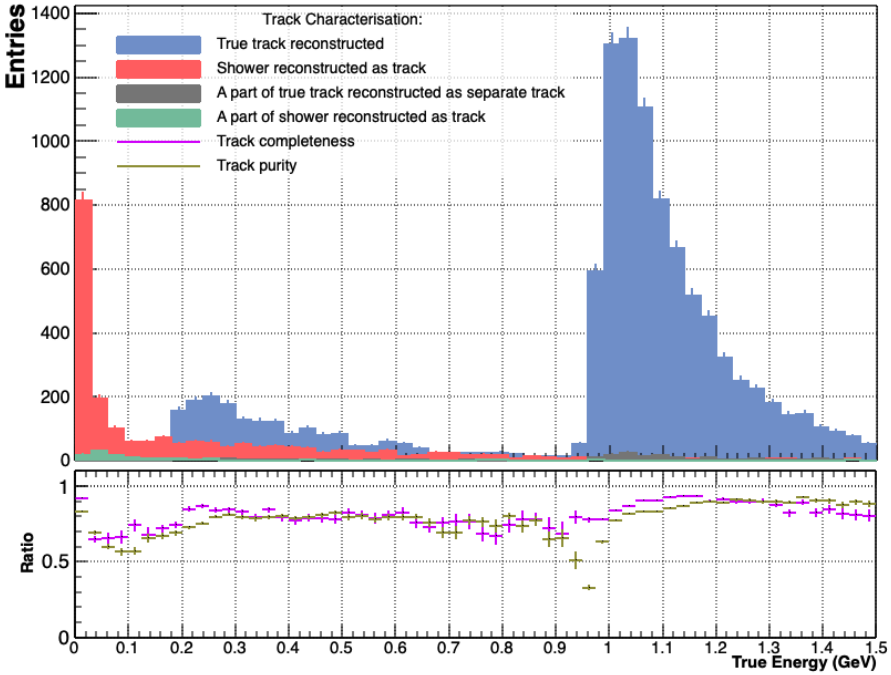


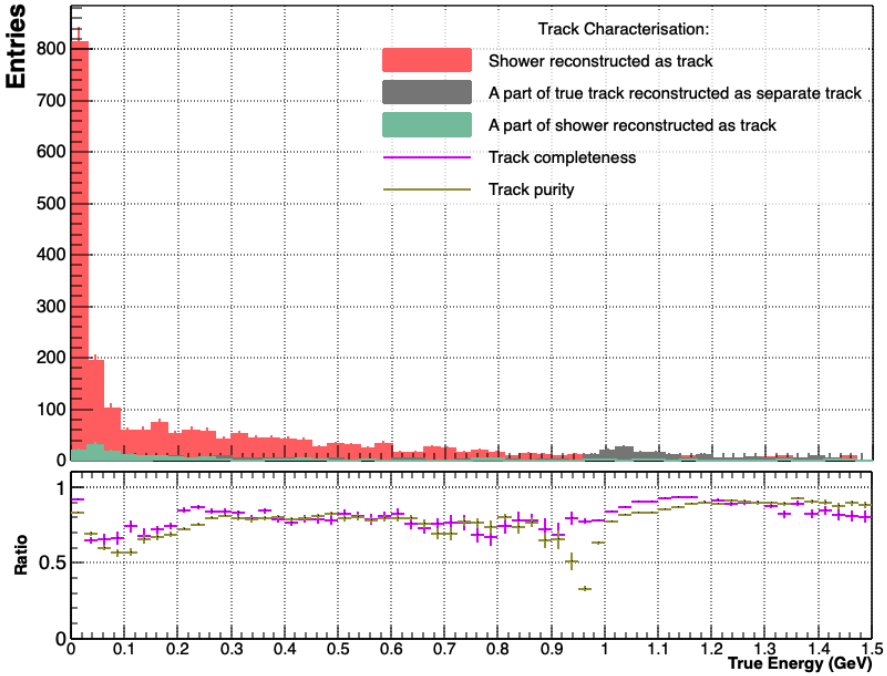


Shower Characterisation

Electron-Neutrino samples (Nu-e)

- **True Particles energy with tracks characterisation in Nu-e samples.**

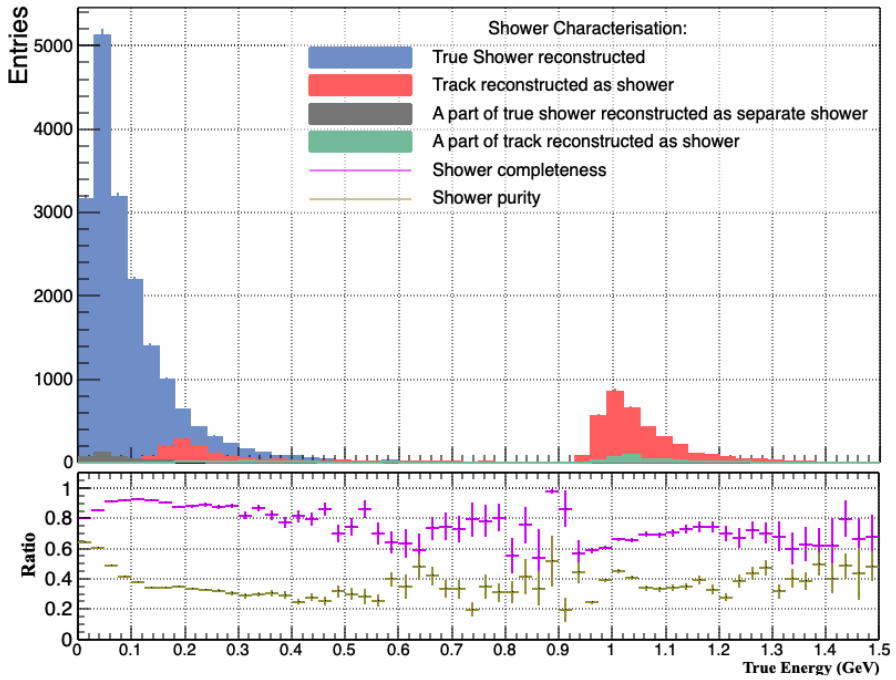


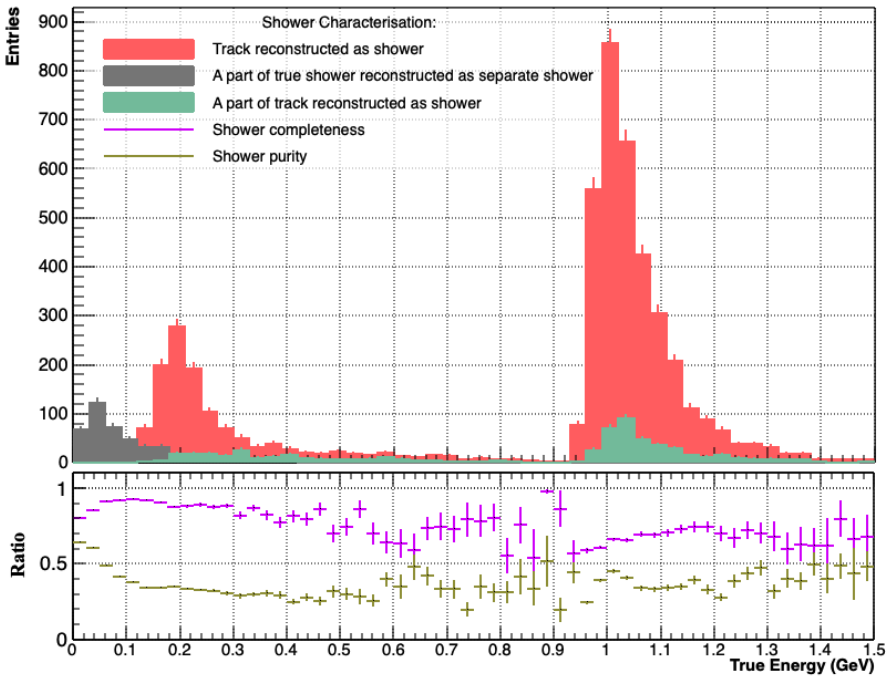


Shower Characterisation

Muon-neutrino samples (CC π^o)

- **True Particles energy with photon shower characterisation from CC π^o events.**

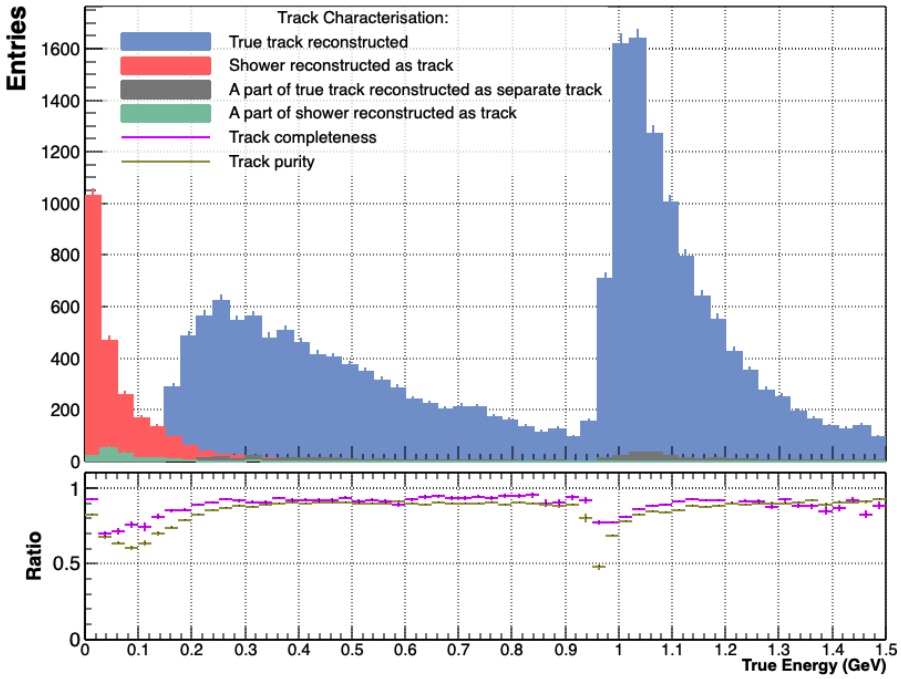


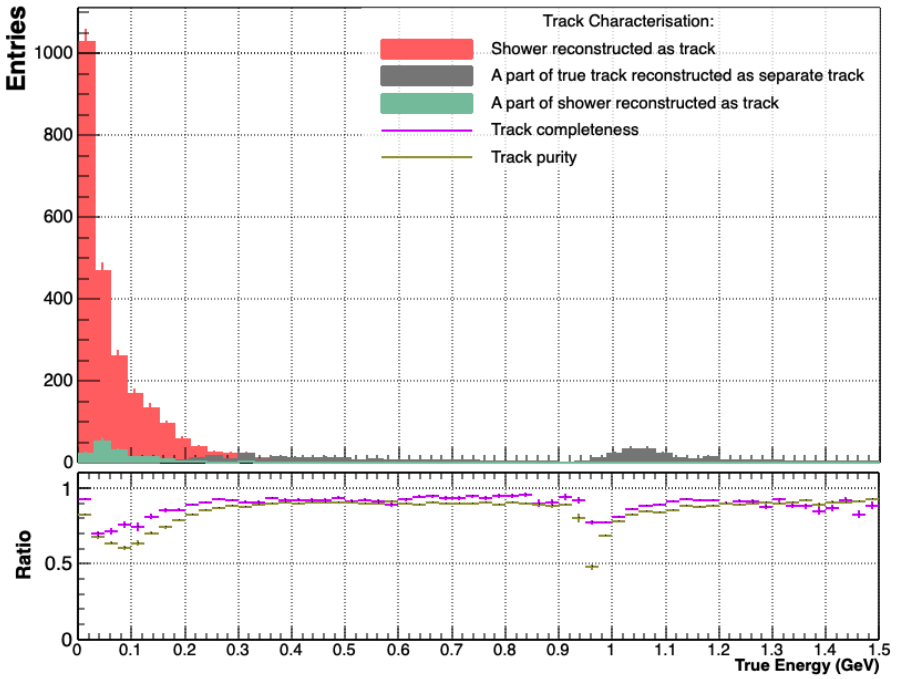


Shower Characterisation

Muon-neutrino samples (CC π^o)

- **True Particles energy with tracks characterisation from CC π^o events.**

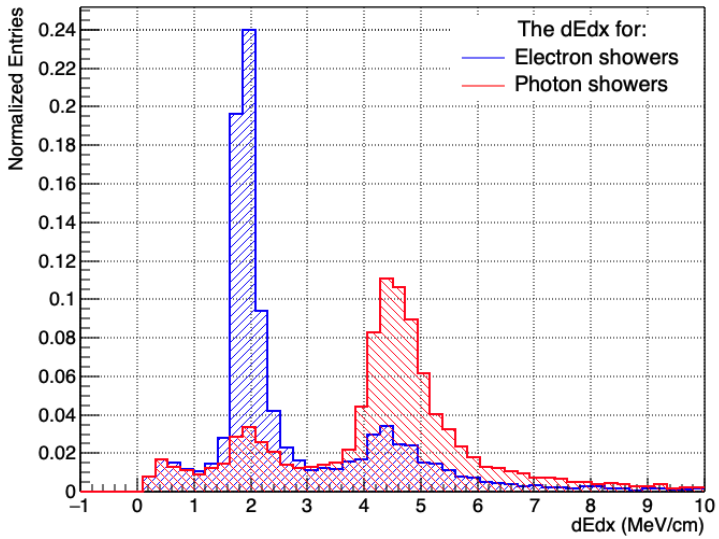




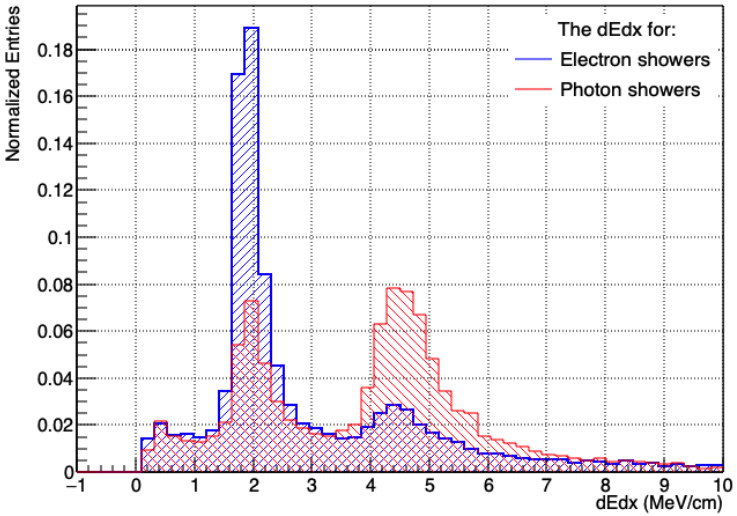
Shower Reconstruction

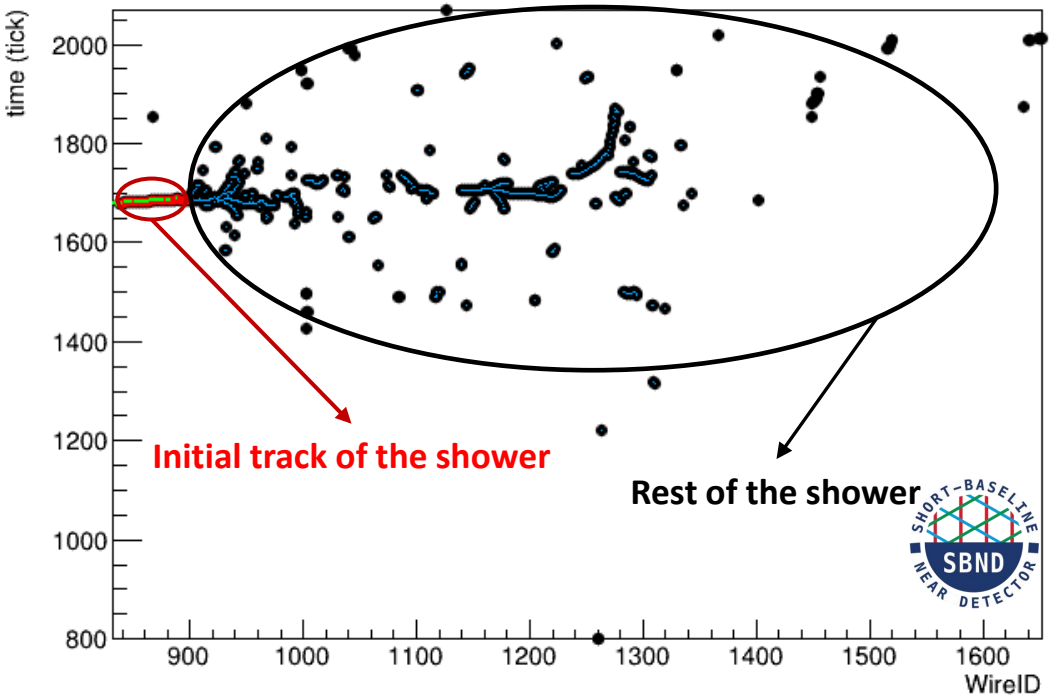
dE/dx Reconstruction

Cheated showers



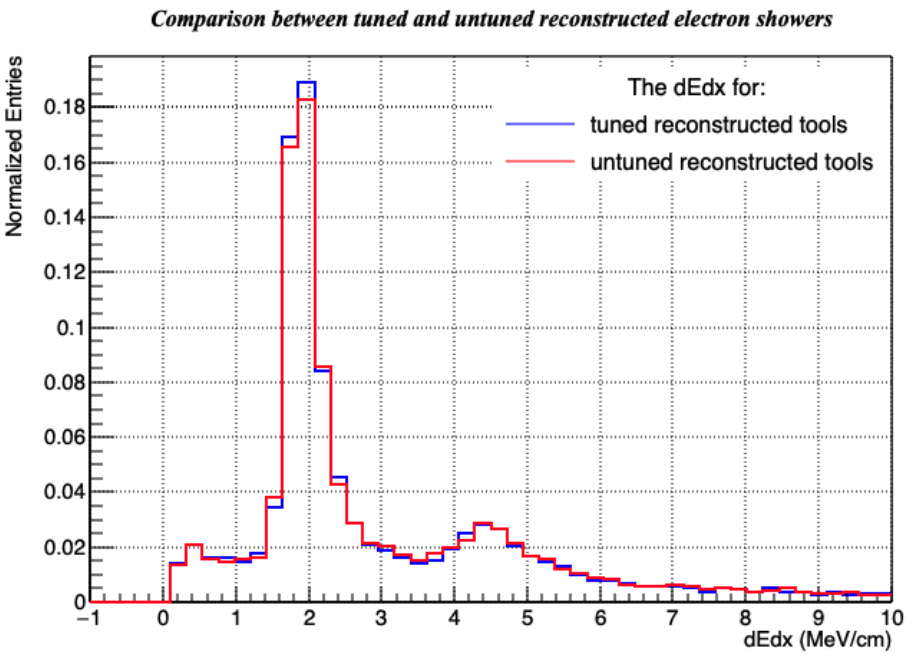
Reconstructed showers

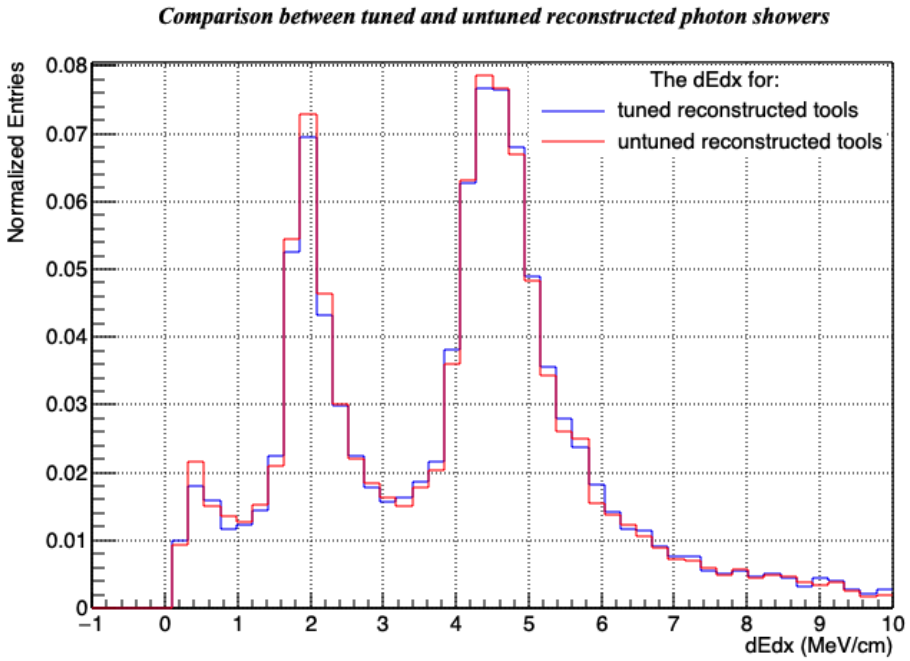




Shower Reconstruction

dE/dx Reconstruction

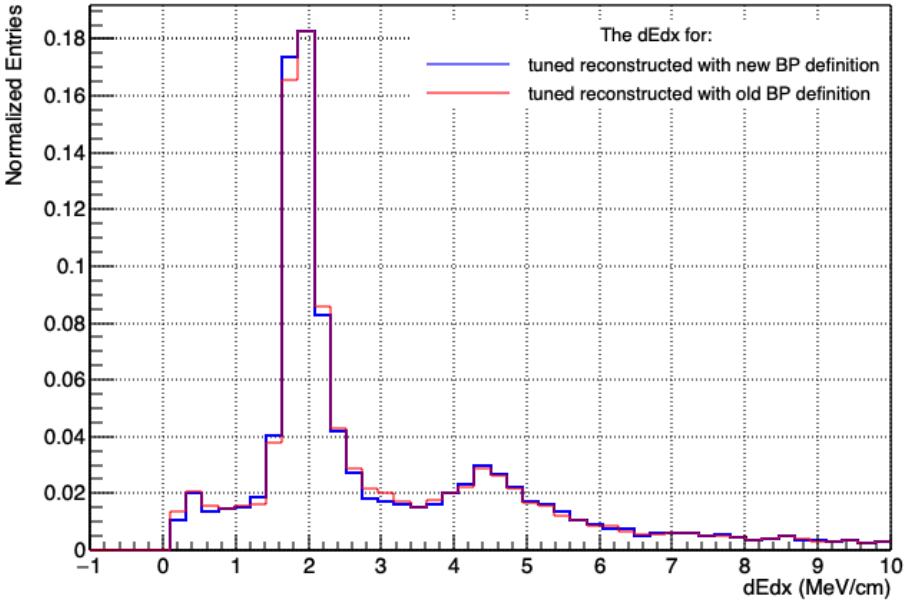




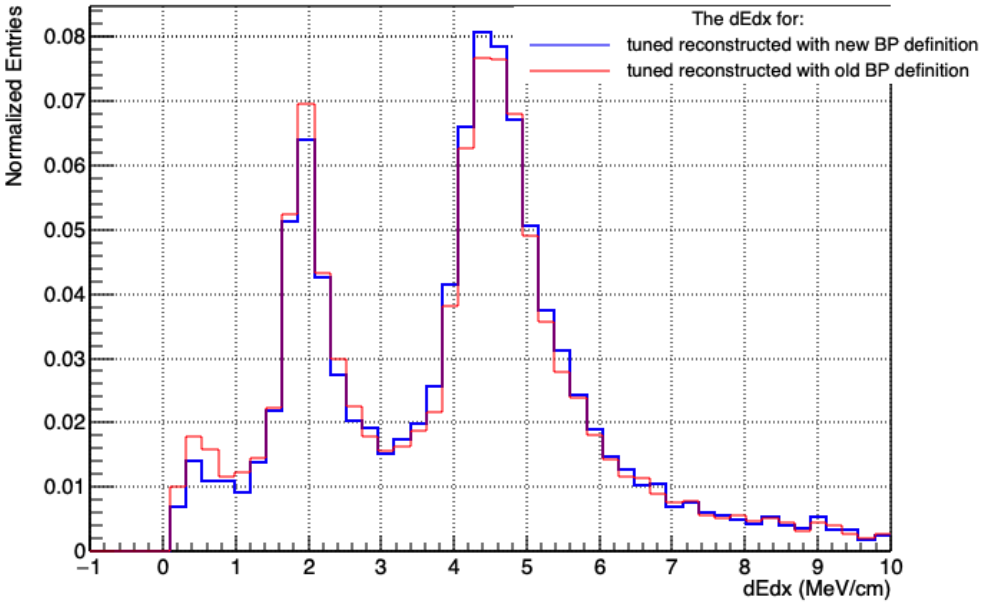
Shower Reconstruction

dE/dx Reconstruction

Comparison between tuned reconstructed electron showers



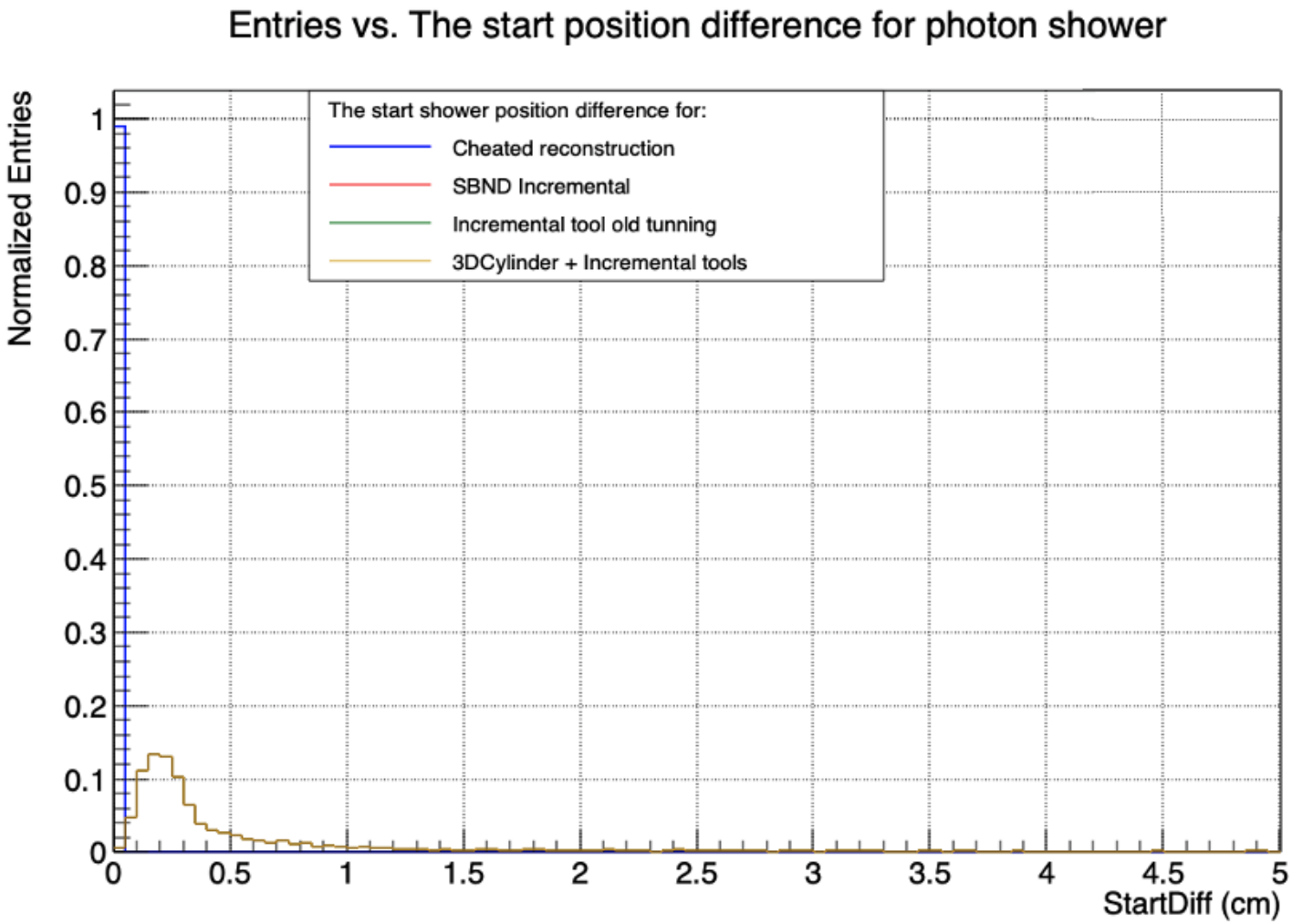
Comparison between tuned reconstructed photon showers



➢ Conclusion:

- The SBN programme can perform a world-leading search for short distance oscillations between neutrinos.
- The SBND experiment will be online soon, and studying the large data sample of neutrino-argon interactions in the GeV energy range is significant for future LArTPCs neutrino experiments such as DUNE.
- There is still work to be done to improve the classification of low energy showers as tracks and classify some of the high energy tracks as showers.
- Tunning the initial track of the shower reconstruction tools improve the reconstruction of dE/dx by about 3%.
- Changing how we choose the best plane of the shower leads to improving the reconstruction of dE/dx by up to 5%.
- There is some work to be done to improve the reconstruction of dE/dx of showers to get a good separation between electron and photon showers.

BACKUP SLIDES


Entries vs. The start position difference for photon shower
The start shower position difference for:
Cheated reconstruction
SBND Incremental
Incremental tool old tunning
3DCylinder + Incremental tools
Normalized Entries
StartDiff (cm)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5