Data/MC issues and next production plan

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ProtoDUNE Sim/Reco meeting

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Introduction

- Short-term goal – publication on detector performance: PD/TPC characterization and response.
- Long-term goal – cross section measurements
- In this talk, I will try to summarize the current status and remaining issues in both short-term and long-term analyses.
- I will also talk about plans for the next data and MC production.

Detector performance

- TPC characterization:
  - Solid results on dead channels, noise, ADC gains
- TPC response:
  - Space charge effects – more details later
  - dQ/dx -> dE/dx using cosmic stopping muons
  - Derive dE/dx for beam particles (muons, pions, protons, electrons) – need better modeling/calibration of SCE
- Photon detector characterization/response:
  - Good progress

Inclusive pion cross section

- Accurate beam information
  - Particle ID and momentum
- Data quality cuts
- Reliable kinetic energy reconstruction
  - Space charge effects
  - Energy loss upstream
  - Stitch tracks across TPC boundary
  - Extra energy loss due to overlapping cosmic ray muons and proton daughters
- Signal definition
  - Cut on scattering angle
  - Signal efficiency and background estimation
- Thin slice method to derive cross section
- Systematics

Beamline information

- A few issues need to be resolved after moving to use the calibrated BI information
  - BI and TPC track matching (see Justin and Jake's talks last week). Resolved?
  - Double band in TOP vs P distribution (Martin's talk today)
  - Missing Cerenkov information from database (reported by Aaron, Jake is investigating)

Data quality cuts

- We need to agree on data quality cuts
  - Filters to remove events with missing FEMBs and during bad HV periods: https://wiki.dunescience.org/wiki/Look_at_ProtoDUNE_SP_data#Filtering_out_.22Bad.22_events
  - Owen and Justin's cuts to remove cosmic ray background and select events with good quality BI information
    - https://indico.fnal.gov/event/20327/contribution/0/material/slides/0.pdf
    - https://indico.fnal.gov/event/20327/contribution/2/material/slides/0.pdf
  - Would be good to provide utility functions to define data quality cuts once they are finalized.

Space charge effects

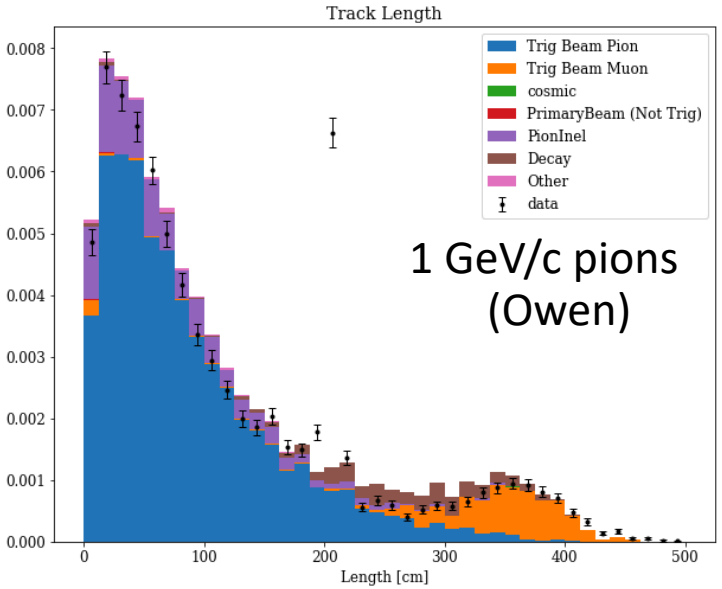
- Mike presented the first data-driven (both spatial distortion and E-field) maps last week:
  - https://indico.fnal.gov/event/20412/contribution/0/material/slides/0.pdf
- The maps can be used to produce new MC samples and correct for SCE in data and MC.
- For the detector performance paper, we will update all MC plots with the improved SCE simulation.
- For cross section measurements, we will need to apply the complete SCE corrections.

Energy loss upstream

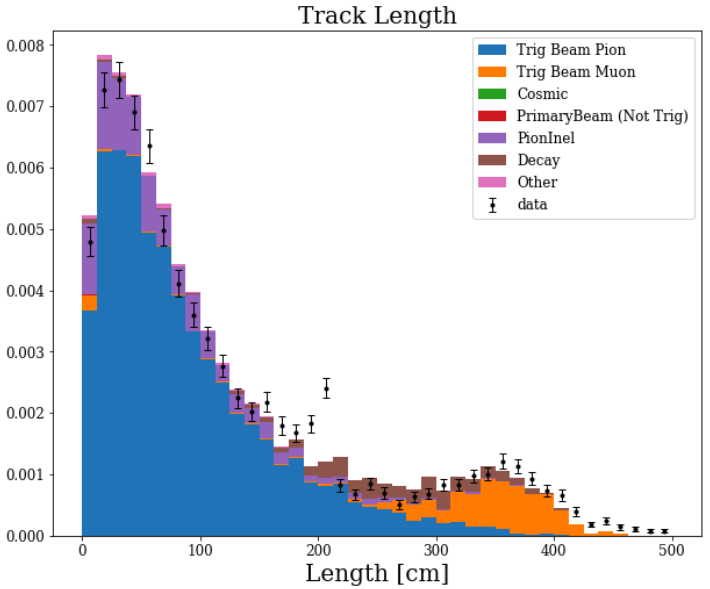
- Already a few studies
  - https://indico.fnal.gov/event/18166/contribution/6/material/slides/0.pdf (Owen)
  - https://indico.fnal.gov/event/19912/contribution/1/material/slides/0.pdf (Heng-Ye)
- Peter Madigan has agreed to look into this recently.

Stitching Tracks

- Field distortion caused by electron diverters – lots of broken tracks.
- Jake wrote an algorithm to stitch broken tracks across TPC boundary:



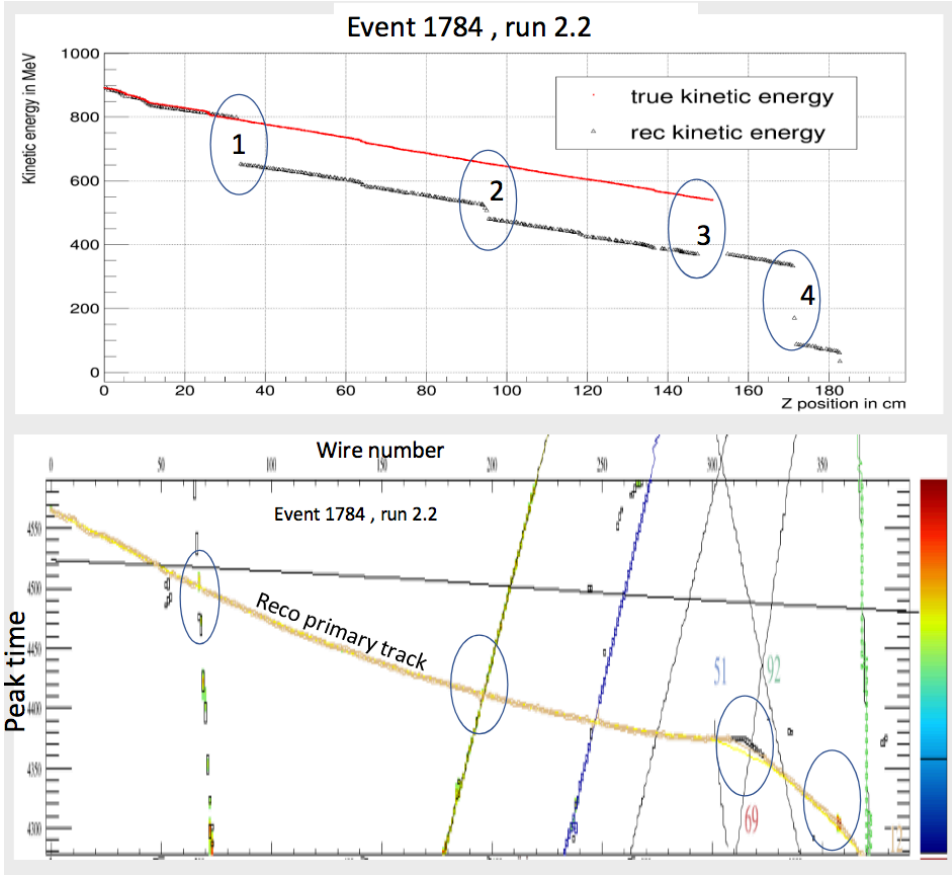
Before stitching

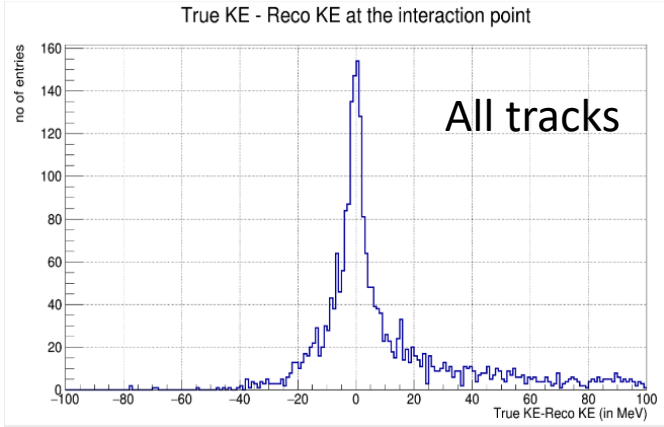


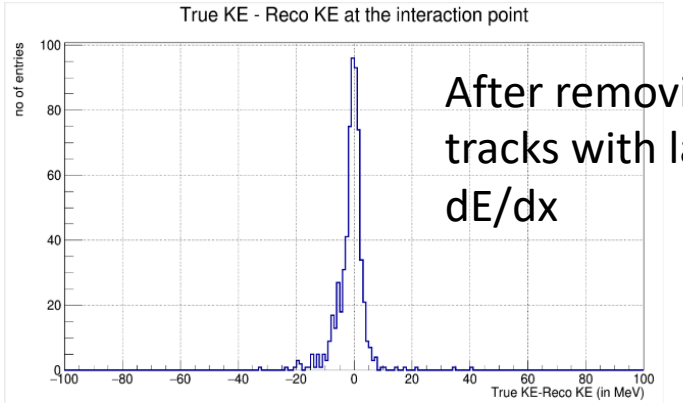
After stitching

Correct for overlapping particles

- Ajib showed last week cosmic muons and proton daughters can affect the pion kinetic energy reconstruction.

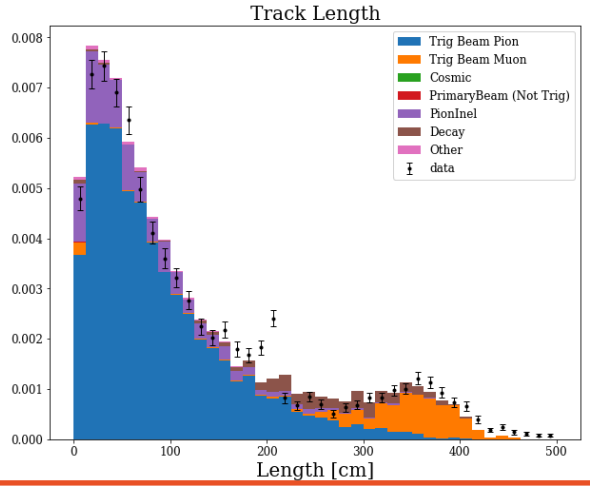






Signal efficiency and background estimation

- Definition of inclusive pion cross section
  - Inelastic scattering + elastic scattering with scattering angle > ?? deg
- Need to study reconstruction efficiency as a function of scattering angle
  - Some preliminary studies by Alex: https://indico.fnal.gov/event/20451/contribution/2/material/slides/0.pdf
- Biggest background seems to be muons
- Half of the PionInel events are protons
  - Can be removed by dE/dx



Next MC production

- Updated SCE simulation from Mike and Hannah.
- Data driven noise simulation from Jingbo.
- Longer electron lifetime – 6 ms?
- Target deadline: April 26

Next data mini-production

- Lots of improvements, see: https://indico.fnal.gov/event/20215/contribution/3/material/slides/0.pdf
- Remaining issues
  - Understanding BI issues
  - Better treatment of dead channels in 2D deconvolution
  - CRT decoder
  - Preliminary SCE correction
  - CNN shower ID?
- Target deadline: soon after MC production is ready