

ProtoDUNE-HD Data Analysis Strategy

Jake Calcutt
DUNE France Workshop
June 5, 2024

Introduction

Example from ProtoDUNE-SP

ProtoDUNE-HD Strategy

- Characterization
- Calibration Consortium
- Analysis NTuples
- Analysis Opportunities

Example from PDSP – Useful references

[PDSP “Performance Paper”](#)

- Details the TPC charge & light readout characterization & calibration
- Technical details (i.e. beam)
 - Some are differences (i.e. readout issues, triggering)

[Pandora Reconstruction in PDSP](#)

[Michel Reconstruction](#)

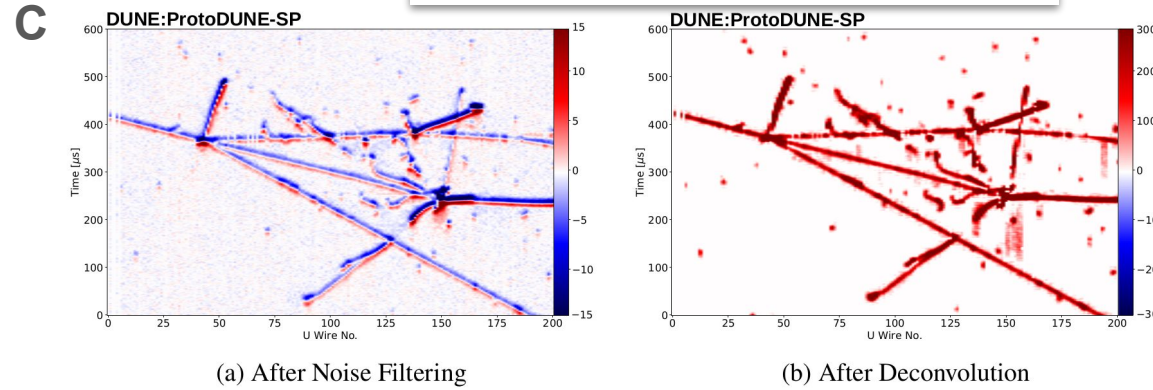
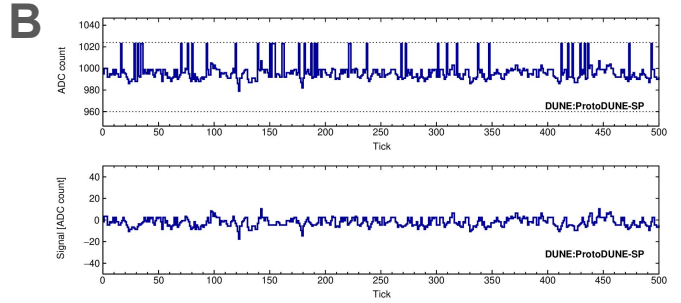
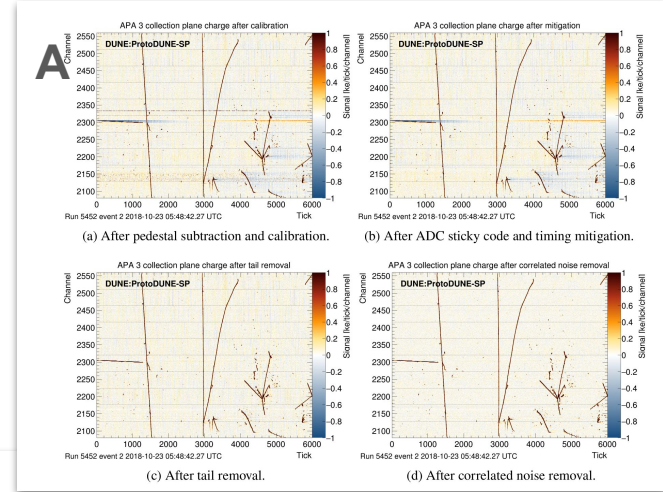
[CNN Track/Shower Separation](#)

Hadron Analyses (WIP)

Example from PDSP – Characterization/Calibration

'Data Preparation'

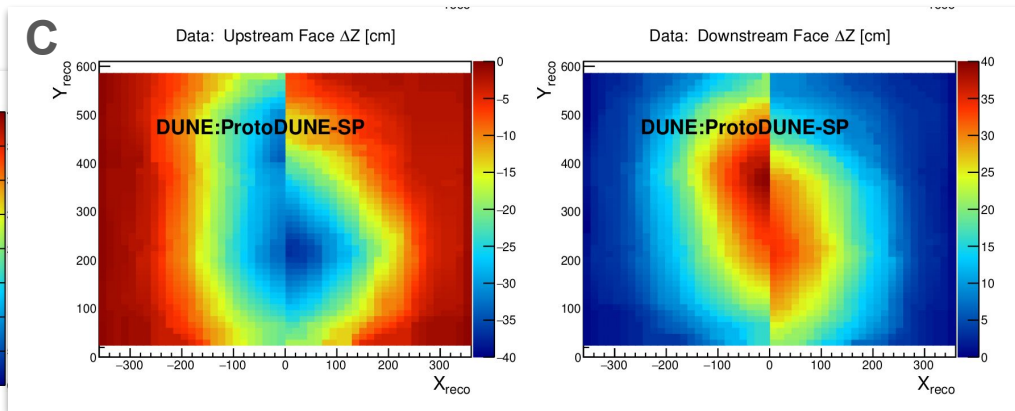
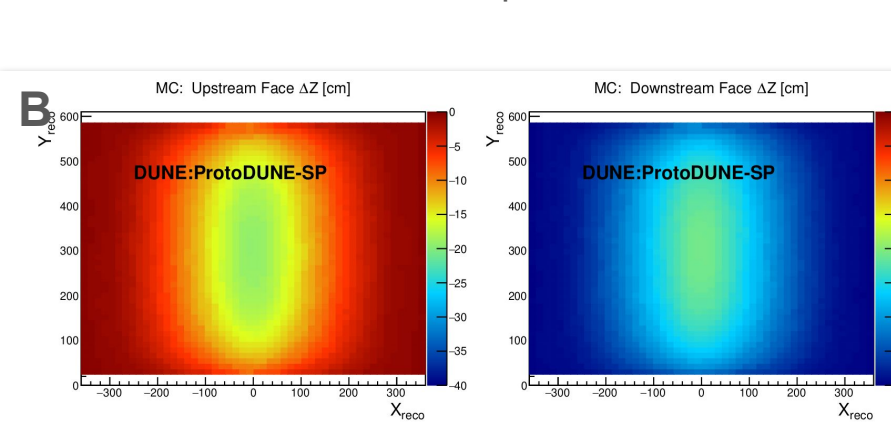
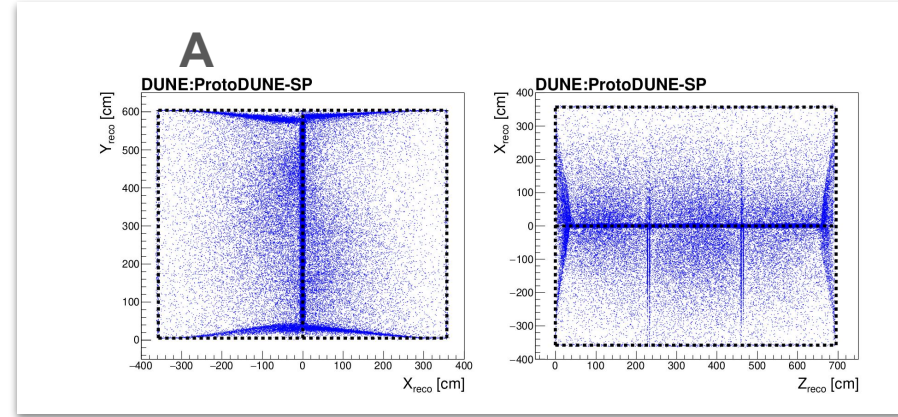
- A. Pedestal, noise characterization
- B. Mitigation of readout issues
- C. 2D Deconvolution



Example from PDSP – Characterization/Calibration

Space Charge Effect Measurement

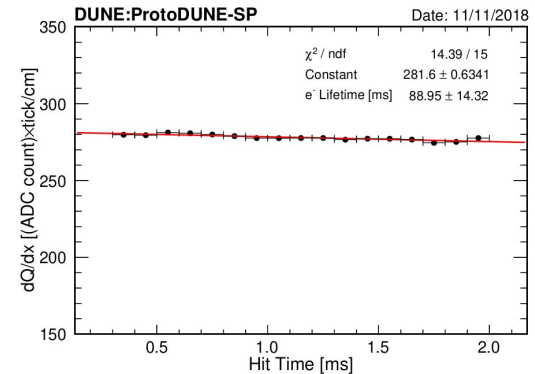
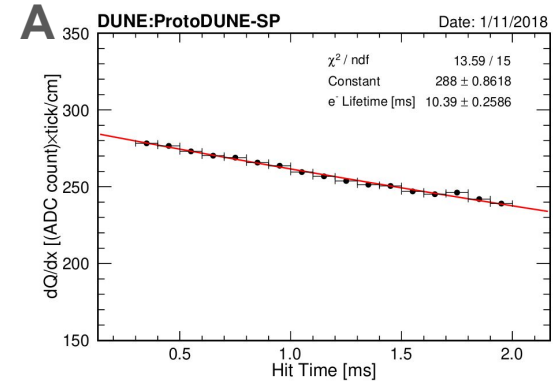
- A. Cathode-crosser endpoints
- B. Simulated SCE Distortions
- C. Measured SCE Distortions
 - a. Use to create data-driven distortion, correction maps



Example from PDSP – Characterization/Calibration

Electron Lifetime using CRT tagged tracks

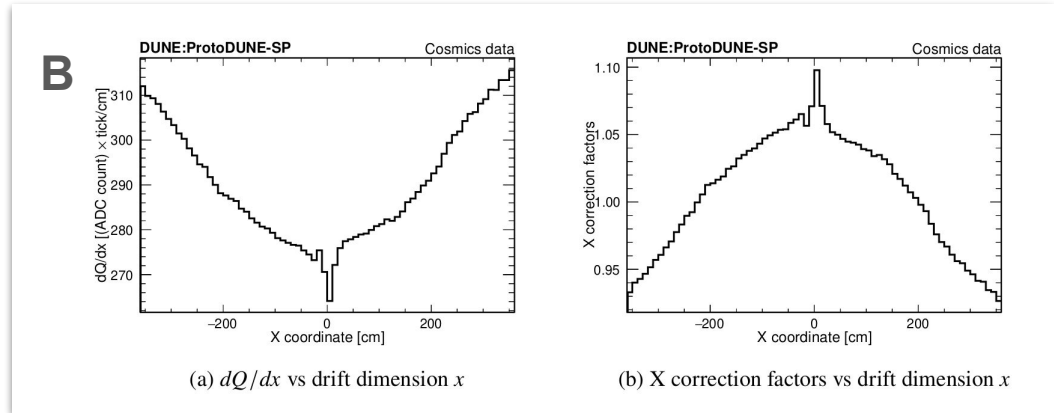
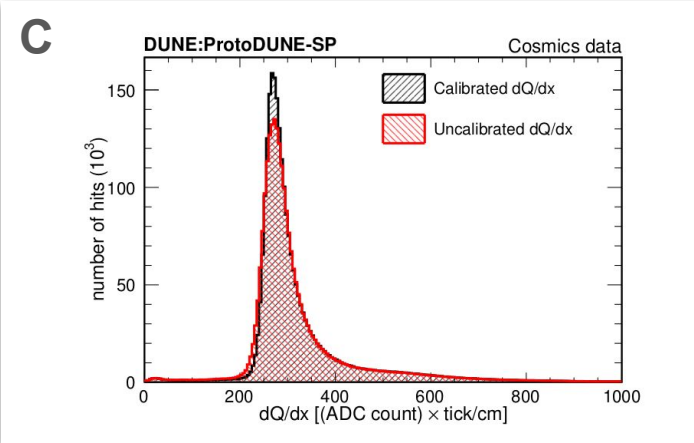
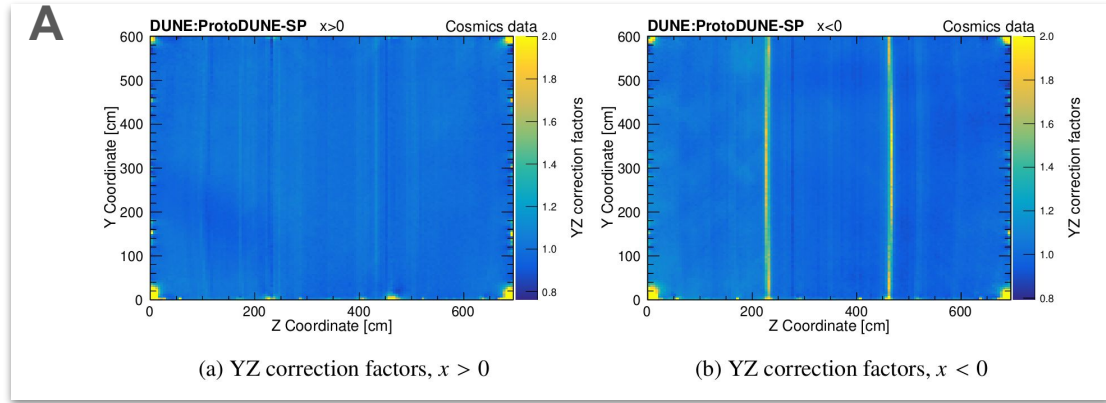
A. 2 lifetime measurements, 10 months apart



Example from PDSP – Characterization/Calibration

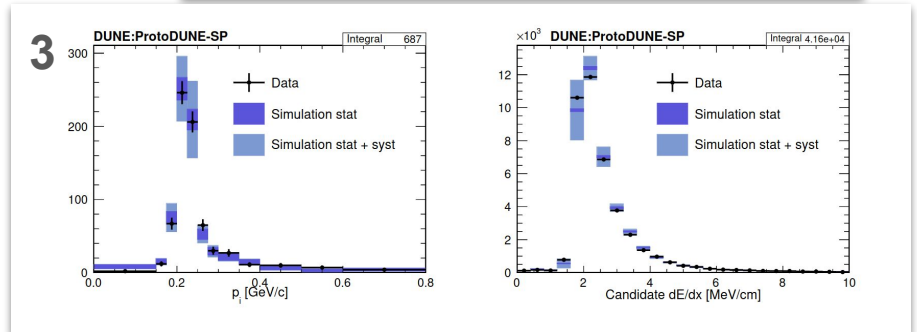
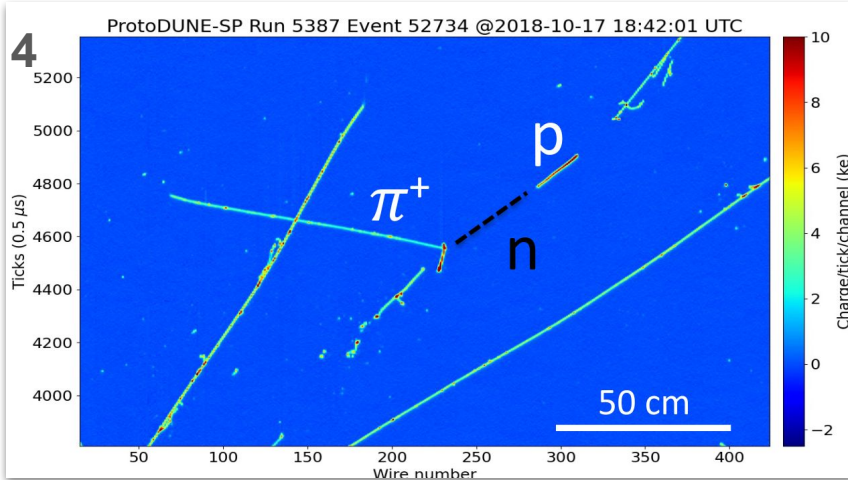
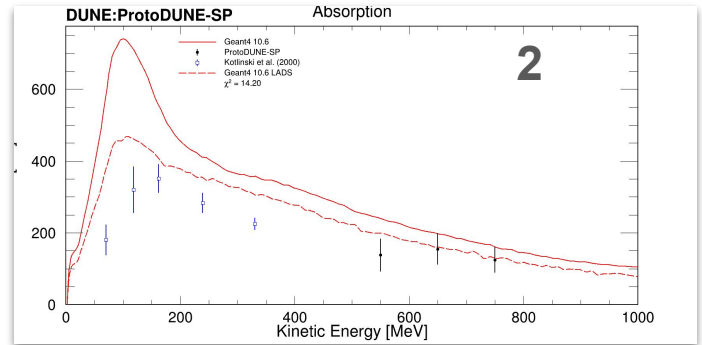
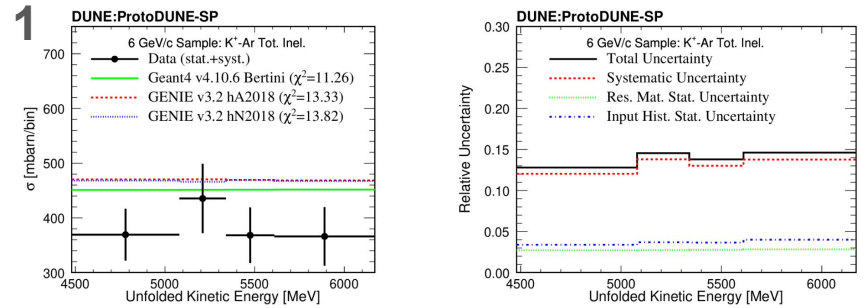
Charge Calibration

- A. Detector equalization – YZ
- B. Detector equalization – X
- C. Calibration results



Hadron Analyses

1. Inclusive Kaon Interactions
2. Exclusive Pion Interactions
3. Secondary Kaon Characterization
4. Secondary Neutron Interactions



ProtoDUNE-HD Strategy (Unofficial!!)

Characterization

Readout issues differ

- No more ‘sticky codes’
- New: “1 Hz” activity, 2-plane APA 1

Now being handled within [WireCell](#) (BNL – Reach out to Wenqiang)

New characterization needs might be discovered as we start to look at data!

- Stay tuned for opportunities!

Calibrations

Will now be overseen by Calibration Consortium

Expect calibration strategy to be similar

- Slightly different set of tools
 - Starting with original-style calibration trees/ntuples
 - Moving on to newer trees/ntuples

Reach out to Rhiannon Jones & Mike Mooney (+ DRA) to contribute

Analysis Trees

Early on in PDSP: ad-hoc, independent analyses + tools

- Eventually moved to centralized, common analysis files (PDSPAnalyzer)
 - Focuses on track-like, beam events for i.e. hadron analyses
 - Can extend to electron showers*
- Can more-or-less use these without much changes for PDHD

My opinion: Every analyzer does not & should not need to make their own analysis trees!

- Common tools help reduce replication of work
- Collaboration is key – “Two heads are better than one”
- Can be integrated into a production setting to get a lot of data, quickly, and make sure its catalogued (necessary for physics releases!!)

Analysis Opportunities

1. Reconstruction improvements

- a. Can we solve the APA1 issue?
 - i. Reach out to Leigh Whitehead

2. Beam-electron characterization

- a. Contingent upon 1.a.?

3. Machine Learning Studies

- a. I* plan to make samples of ML inputs for i.e. [NuML](#), [MLReco](#)
 - i. Goal: Analyzers don't have to mess around with LArSoft to start training/developing models
 - 1. Integration into LArSoft comes later

4. Hadron Analyses

- a. Possibly contingent on 1.a.
- b. Understand feasibility of various configurations
 - i. Higher-momentum beam + use APA2?

* Looking for assistance!

Thank you!