Update on Simulation and Calibration Topics for ProtoDUNEs
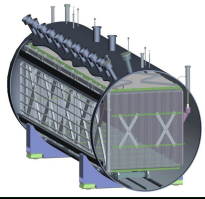
Michael Mooney

Colorado State University
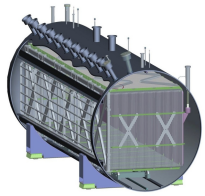
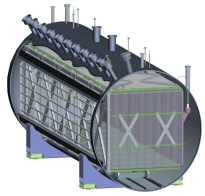ProtoDUNE-SP DRA Meeting

October 12th, 2017

Outline

♦ **Updated Noise Model for ProtoDUNE-SP**

♦ Space Charge Effect Calibration Studies
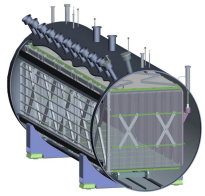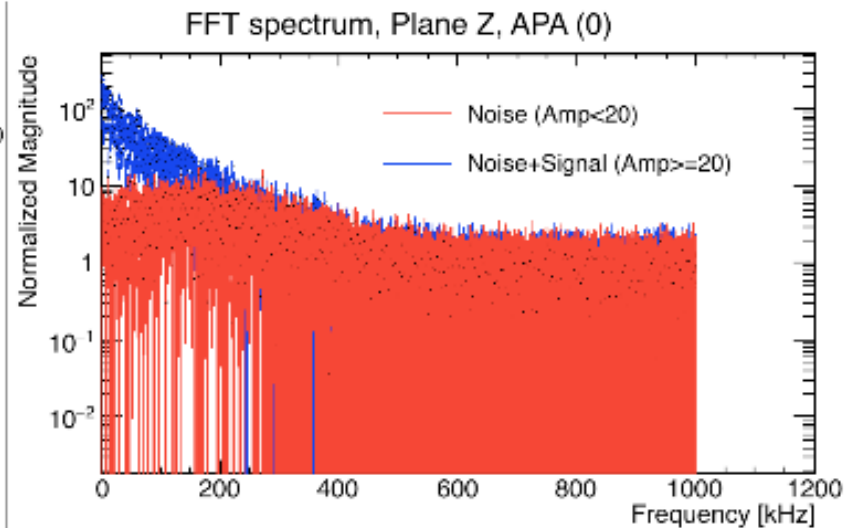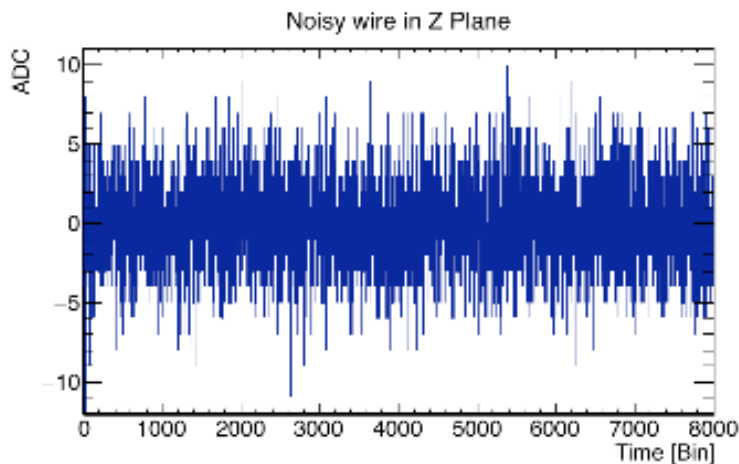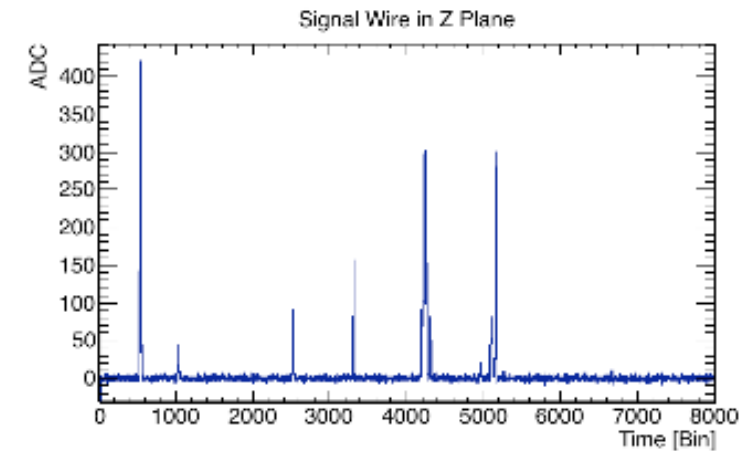
♦ Other Studies In Progress

Noise Model Introduction

♦ Updated noise model in ProtoDUNE-SP to include "realistic" estimate of noise w/ wire-length-dependence

- Comes from studies at MicroBooNE with data
- See MicroBooNE noise paper
- Original work by Jyoti Joshi (BNL), Mike Mooney (BNL/CSU), and Adam Lister (Lancaster)
- Thanks to Jingbo Wang (UC Davis) for implementing version of LArSoft code for DUNE!

♦ Suitable for ProtoDUNE-SP and DUNE FD

- Very similar FE ASIC, electrodes, as in MicroBooNE
- But should use actual DUNE to improve model, when available
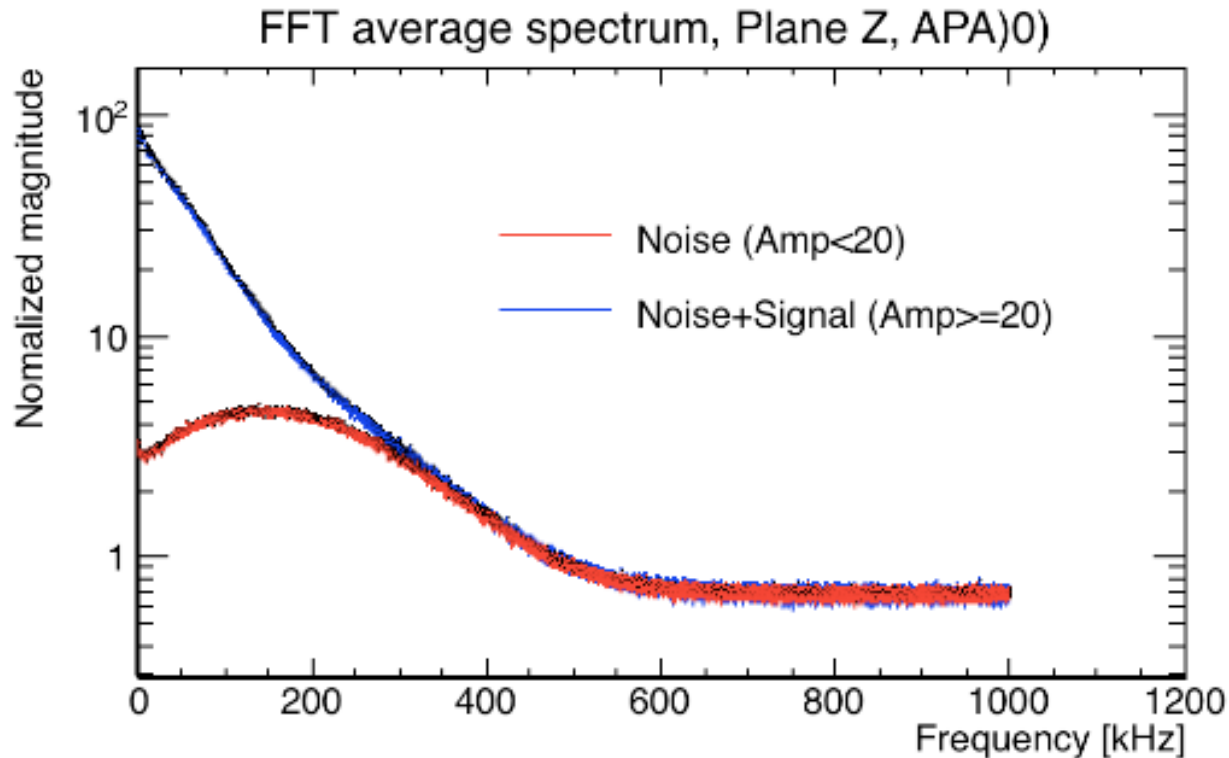
♦ Pushed to feature branch of dunetpc (Jingbo has details)

- ◆ Noise generated in frequency domain, then inverse FFT (float), then waveform digitized
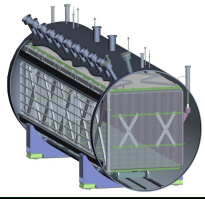
- ◆ Only intrinsic FE ASIC noise included (for now)

Signal Wire in Z Plane

Noisy wire in Z Plane

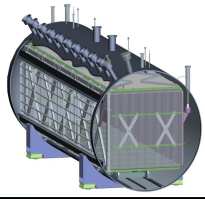FFT spectrum, Plane Z, APA (0)

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FFT average spectrum, Plane Z, APA)0)

♦ Noise + signal FFT shown for collection plane – checks out

♦ Can carry out signal processing deconv. filter studies now
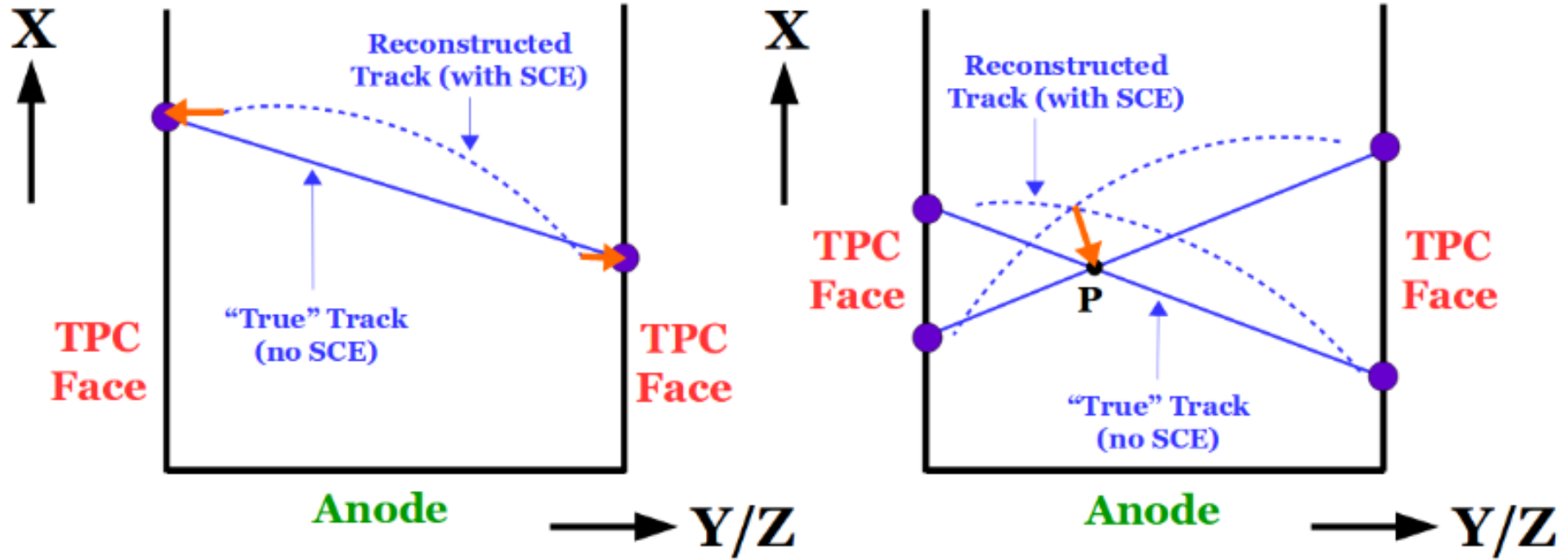
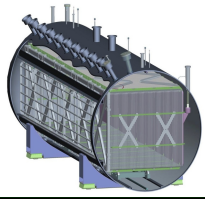• Requires noise simulation to be pinned down

Outline

♦ Updated Noise Model for ProtoDUNE-SP

♦ **Space Charge Effect Calibration Studies**

♦ Other Studies In Progress

- Two samples of t_o-tagged tracks can provide SCE corrections:

  - <u>Single tracks</u> – enable corrections at TPC faces by utilizing endpoints of tracks (correction vector approximately orthonormal to TPC face)

  - <u>Pairs of tracks</u> – enables corrections in TPC bulk by utilizing unambiguous point-to-point correction looking at track crossing points

- Require high-momentum tracks (plenty from cosmics, beam halo)

Toy MC SCE Studies

- Mike M. working on using t_o-tagged cosmics to measure spatial distortions in TPC bulk
  - Studies ongoing with MicroBooNE – team is assembled, working
- Have developed framework to take tracks from LArSoft and utilize in calibration code – <u>currently validating with toy MC</u>
  - Also studying with ProtoDUNE-SP geometry
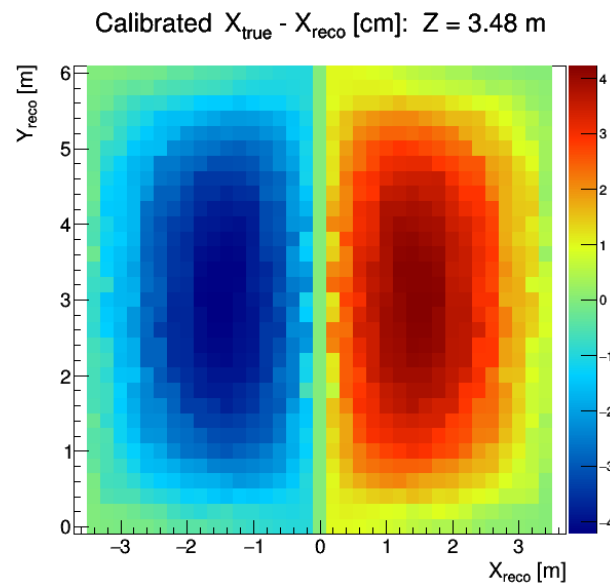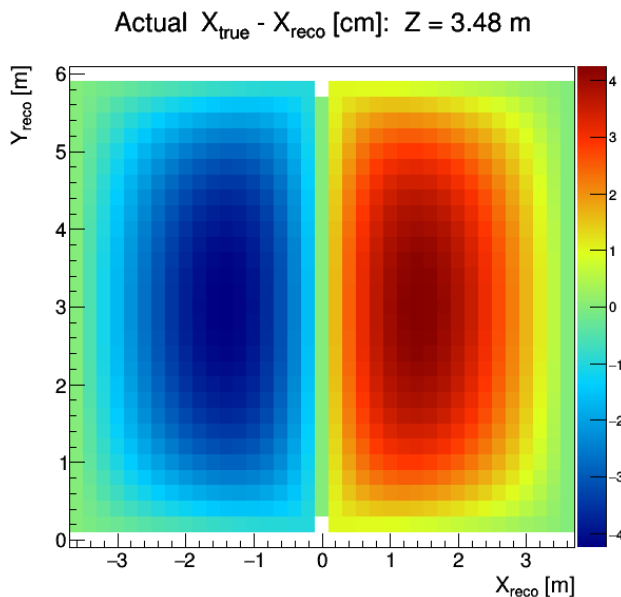
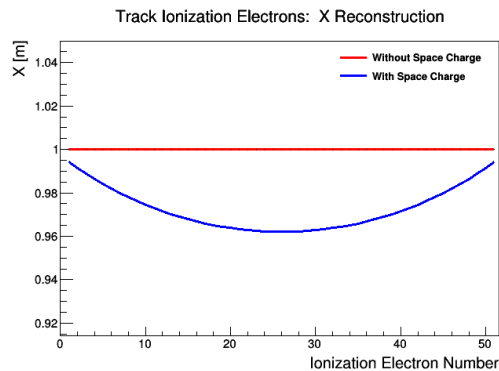**Toy MC:**
10000
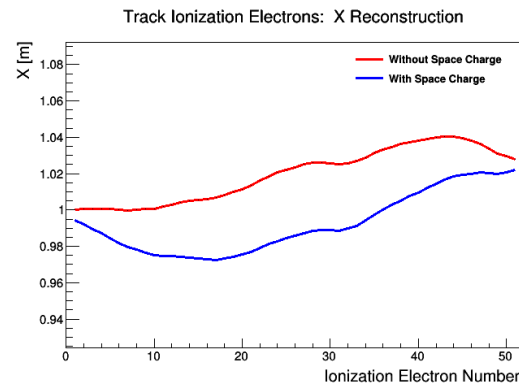**Isotropic**
Muons with
no MCS
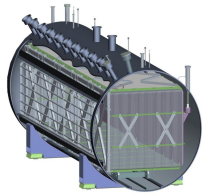
Including MCS Effects

♦ One important possible source of bias: Multiple Coloumb Scattering (MCS) – can complicate estimation of "cosmic truth track" (straight line between end points)

• Implemented MCS effects in toy MC track sample so potential bias/smearing can be studied rigorously
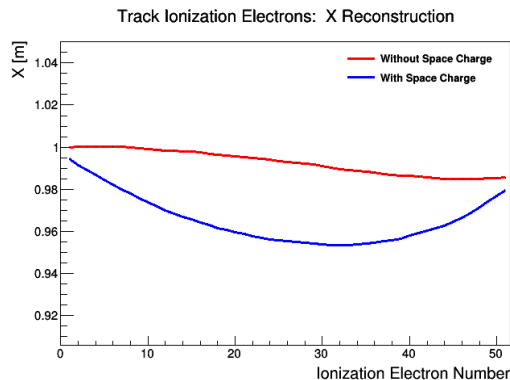
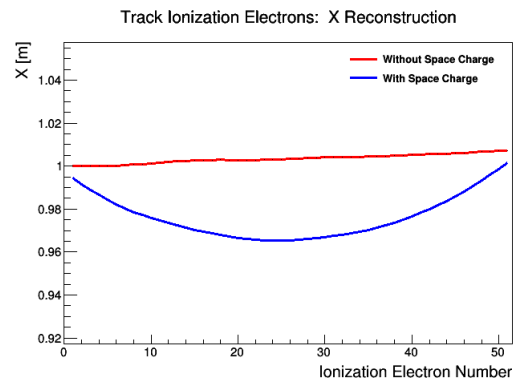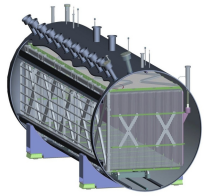

Toy MC: Muon w/o MCS

**Toy MC: 1 GeV Muon w/ MCS**

Toy MC: 3 GeV Muon w/ MCS

Toy MC: 6 GeV Muon w/ MCS

♦ Produce calibration result again with MCS effects included

- Assume all muons are 3 GeV (many cosmics above this threshold)

- Degradation of performance noticed, but obvious ways to improve:

  – Include more statistics (this is a small sample)

  – Change handling of end points (currently don't fix end point to TPC face, only start point)

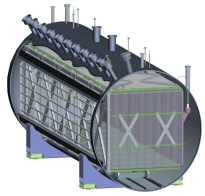♦ <u>Next step</u>: more toy studies, use LArSoft tracks in calibration

Actual $X_{true} - X_{reco}$ [cm]: Z = 3.48 m

Calibrated $X_{true} - X_{reco}$ [cm]: Z = 3.48 m
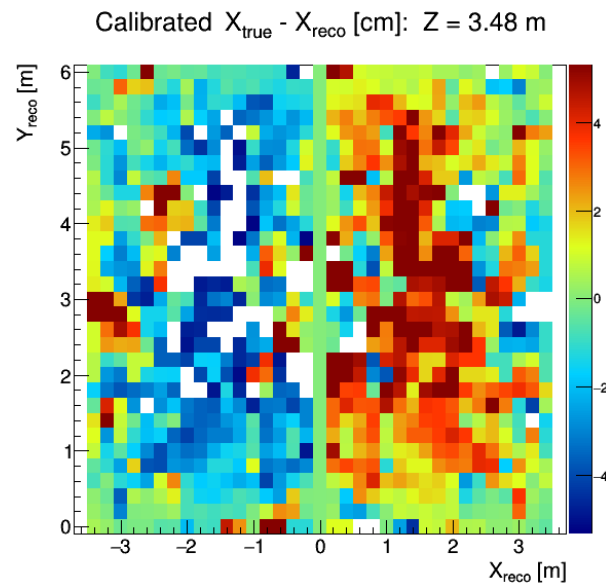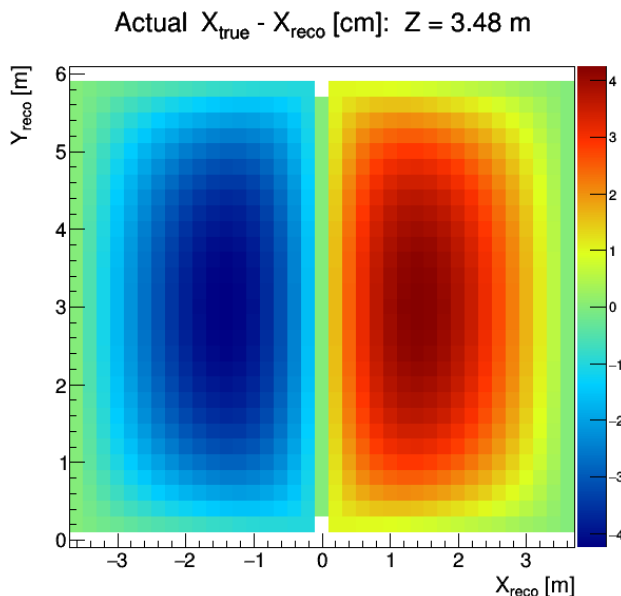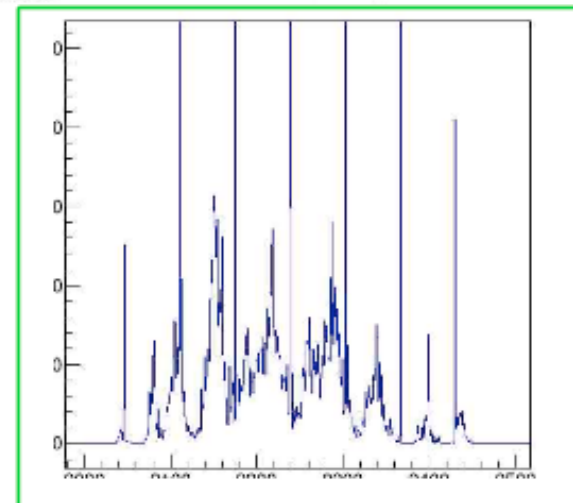
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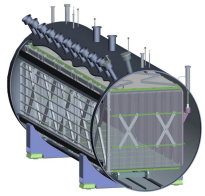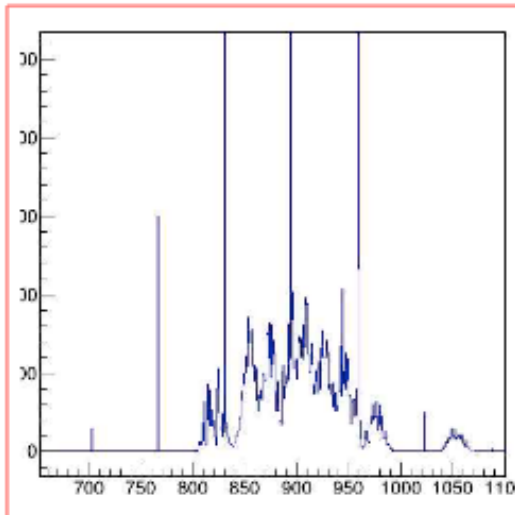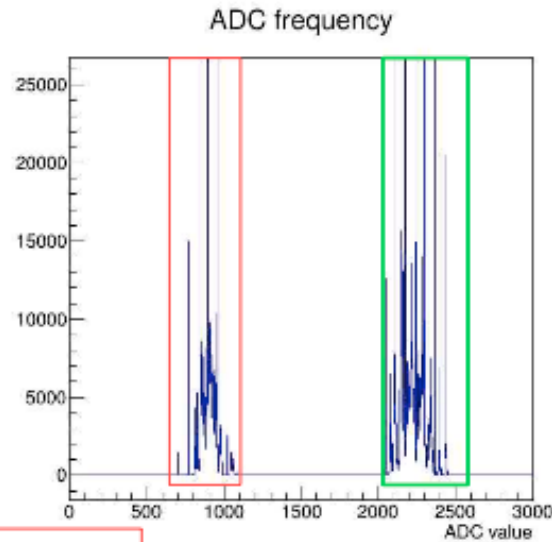10000
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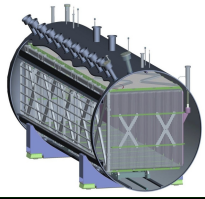
Outline

♦ Updated Noise Model for ProtoDUNE-SP

♦ Space Charge Effect Calibration Studies

♦ **Other Studies In Progress**

Cold Elec. Calibration

- ♦ CSU grad student Ryan LaZur (w/ Mike) ramping up to study noise, cold elec. calibration for ProtoDUNE

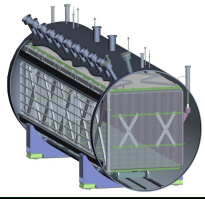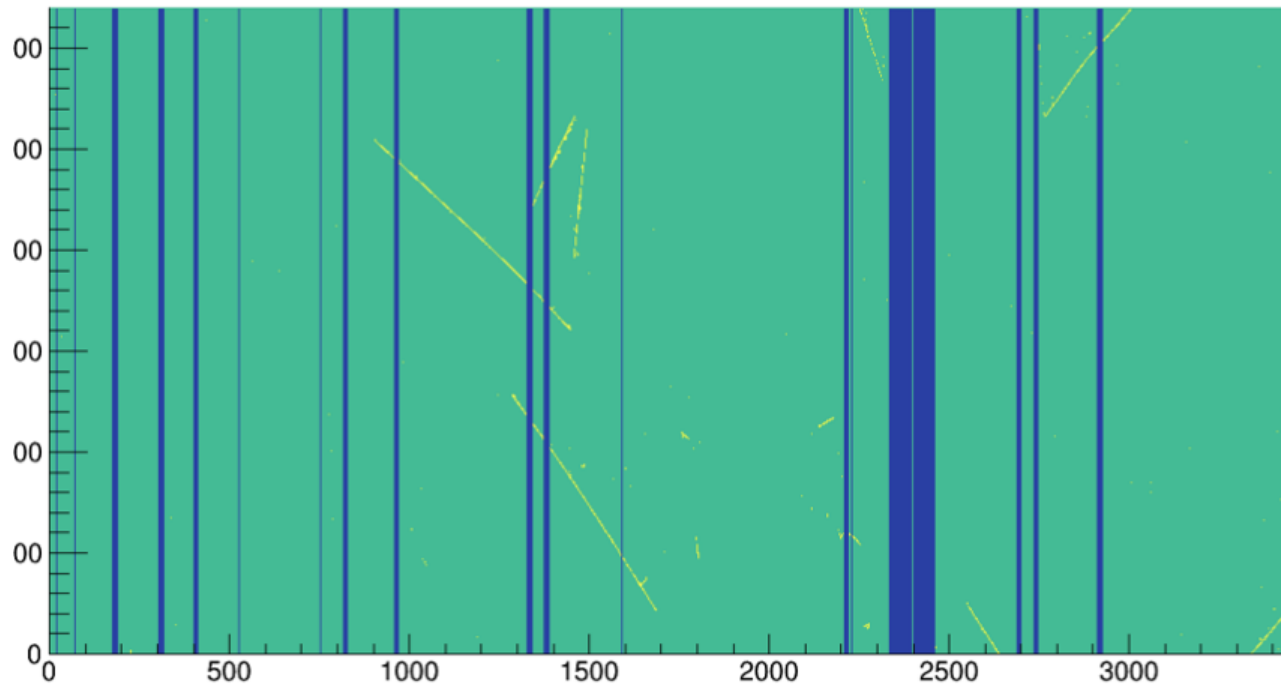- ♦ FE ASIC calibration, characterizing and ameliorating ADC issues

♦ CSU undergraduate student Alex Flesher working with Mike to investigate Ar-39 as potential calibration source for DUNE FD

- Plenty of it to go around, uniform in drift direction, well-known energy spectrum

- Updates forthcoming – Alex still getting ramped up

Calibration Using Ar-39

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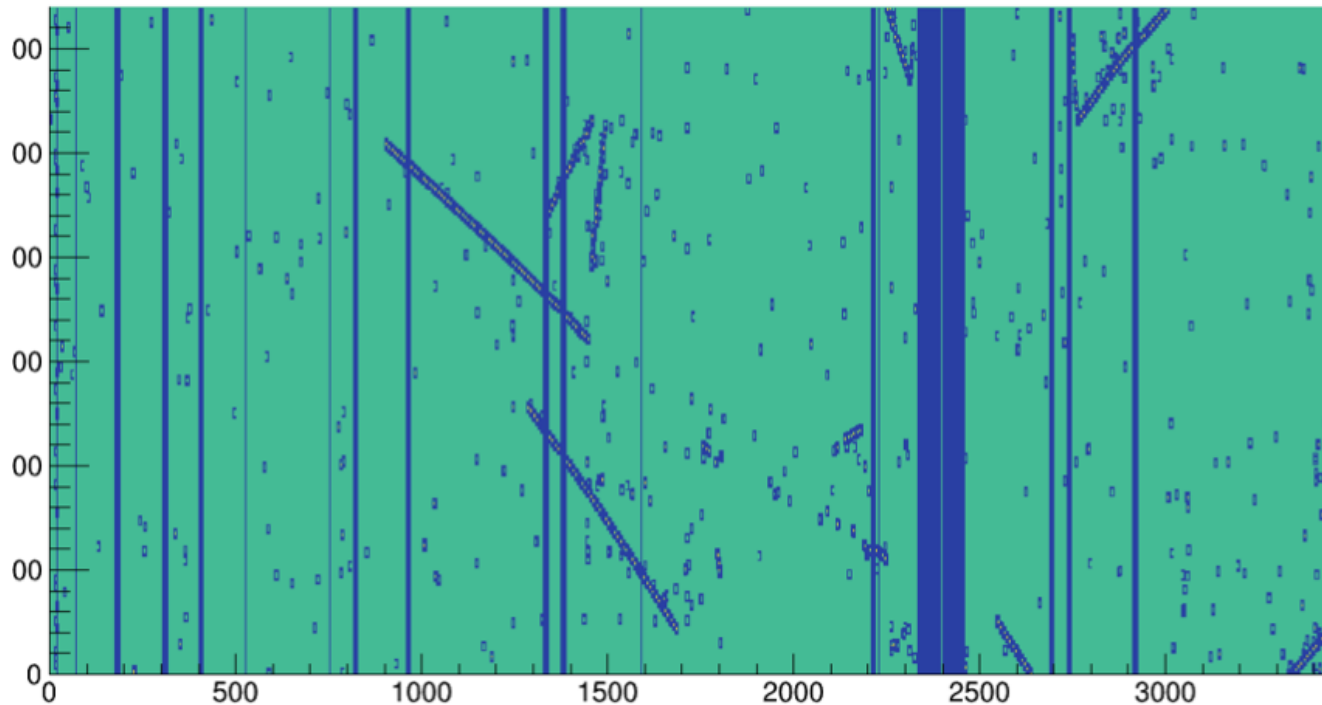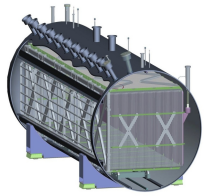
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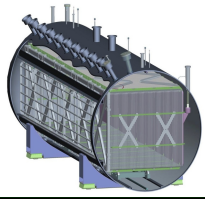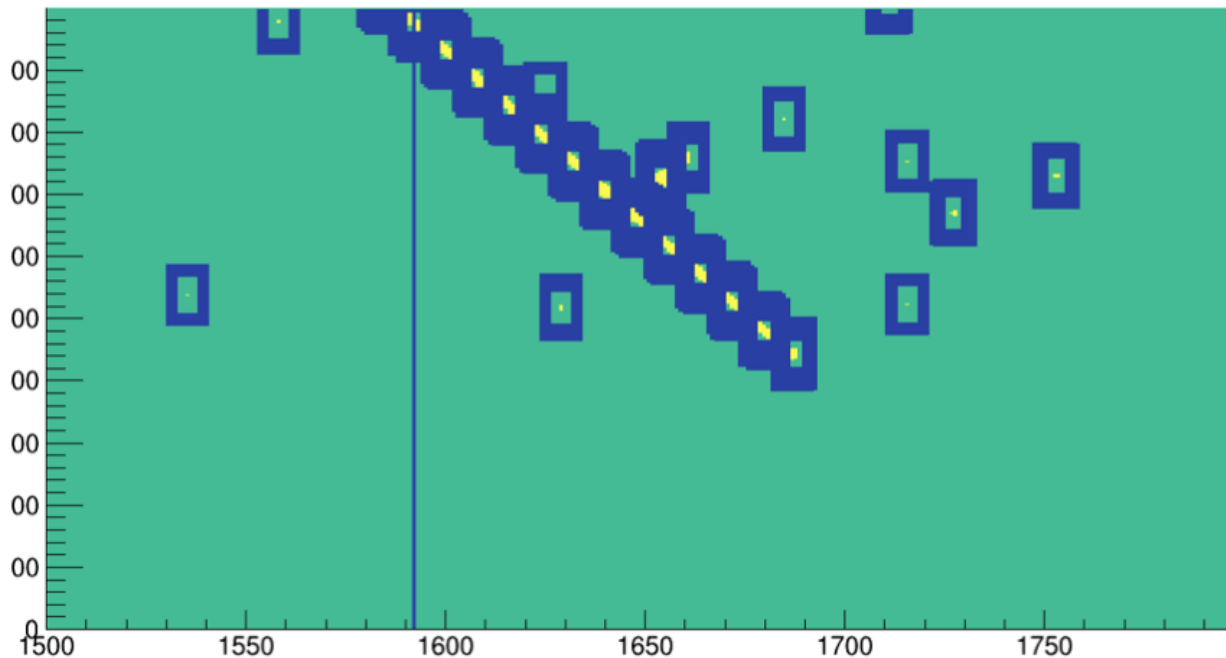
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BACKUP SLIDES