

# ProtoDUNE Calibration Outline

(Draws heavily from Tingjun's Calibration talk from 7/14/16)

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# I. Electronics Response

A. Gain from charge injection

B. Dead channels from cosmics

C. ADC linearity (e.g., stuck bits) from DAC, pulsers

D. Timing response (transfer function) from benchtop?

E. Noise model from in-situ random triggers

## Deliverables:

- Channel-by-channel gain corrections for data; model for LArSoft
- Dead channel map for LArSoft
- ADC linearity/stuck bit corrections and model
- Transfer function model for LArSoft
- Noise model for LArSoft
- Noise mitigation for data (e.g., coherent noise subtraction)

## II. Drift Velocity--- $v(x,y,z,t)$

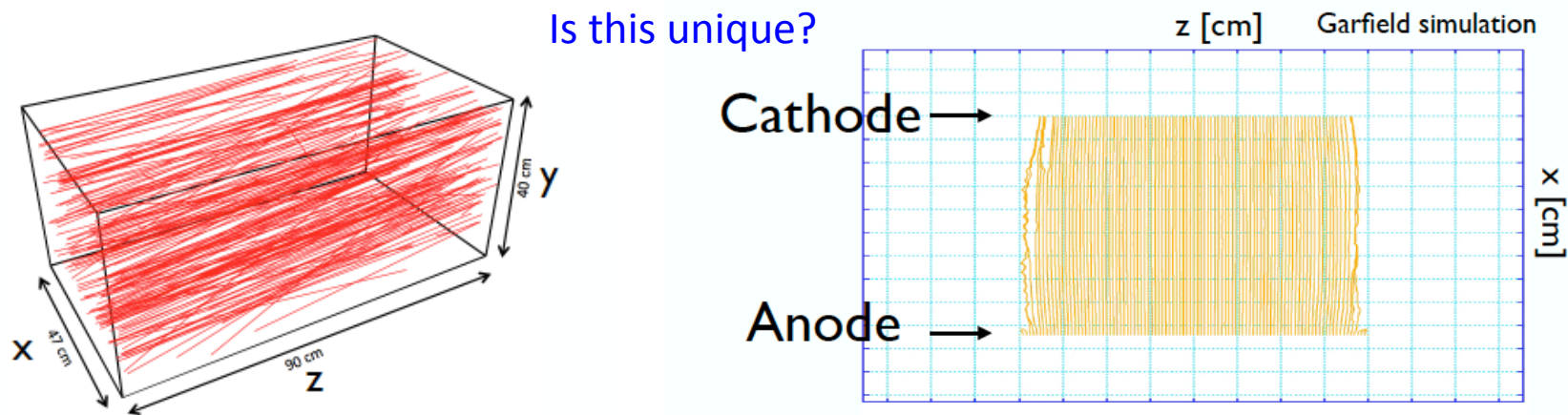
A. Horizontal tracks from counters with  $t_0$

B. APA/CPA crossing tracks

C. Test against temperature measurements and field expectations

### Deliverables:

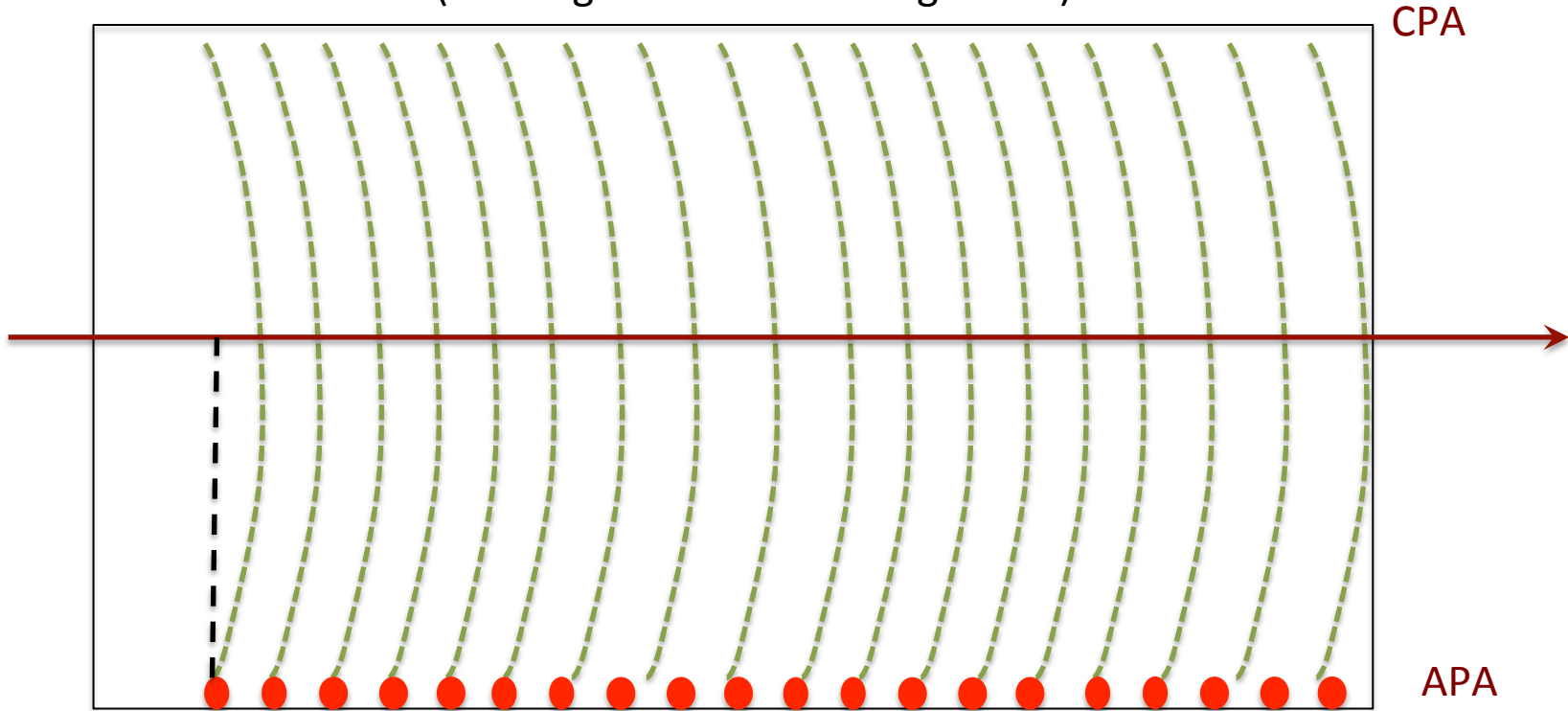
- Velocity map as a function of position and time for reconstruction
- Uncertainty on LArSoft model ( which uses temperature and field expectations)



# Drift velocity $v(x,y,z,t)$

Is a simple map enough?

(Looking Down on field cage---z-->)



### III. Electron lifetime $\tau(x,y,z,t)$

- A. Tracks from counters with  $t_0$  (using  $v(x,y,z,t)$ )
- B. APA/CPA crossing  $\mu s$
- C. Test against purity monitor expectations

#### Deliverables:

- Velocity map as a function of position and time for reconstruction
- Uncertainty on LArSoft model using temperature and field expectations

## IV. Recombination

- A. Stopping muons (using  $v(x,y,z,t)$ ,  $\tau$ , gain, etc.)
- B. Test against Birk's or "Modified Box" model

### Deliverables:

- Recombination correction for data:  $dQ/dx$  vs.  $dE/dx$
- Uncertainty on recombination model in LArSoft

## IV. Diffusion

A. Pulse widths from cosmics vs. drift time

B. Test against space charge model

### Deliverables:

- Diffusion model for LArSoft

## V. Full Field Map: $E(x,y,z,t)$

### A. Crossing cosmic tracks using counters(+TPC?)

#### Deliverables:

- Field map for LArSoft



V. Wire Field response (particularly for  $u/v$ )

A. Horizontal tracks?

B. Calculation?

Deliverables:

- Field response correction

## VI. Energy Scale

- A. Test on stopping muons using counters, recon
- B. Test on Michels, compare to LArSoft

### Deliverables:

- Global correction if needed
- Uncertainty on energy scale