



Space Charge Corrections to Calorimetry

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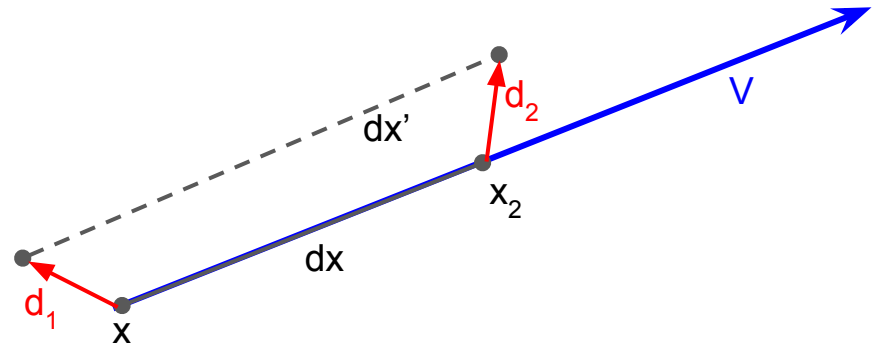
ProtoDUNE Sim/Reco Meeting

May 7, 2019

Spatial correction method for calorimetry

1. Rescale normalized direction (\mathbf{V}) by dx : $\mathbf{x}_2 = \mathbf{x} + dx \cdot \mathbf{V}$
2. Correct position (\mathbf{x}) for SCE: \mathbf{d}_1
3. Correct end of dx (\mathbf{x}_2) for SCE: \mathbf{d}_2
4. Calculate dx' from SCE corrections ($dx' = |dx \cdot \mathbf{V} + \mathbf{d}_2 - \mathbf{d}_1|$)

- Advantages:
 - Don't have to correct \mathbf{V} or γ
 - Apply correct SCE correction
 - Direct calculation of dx'



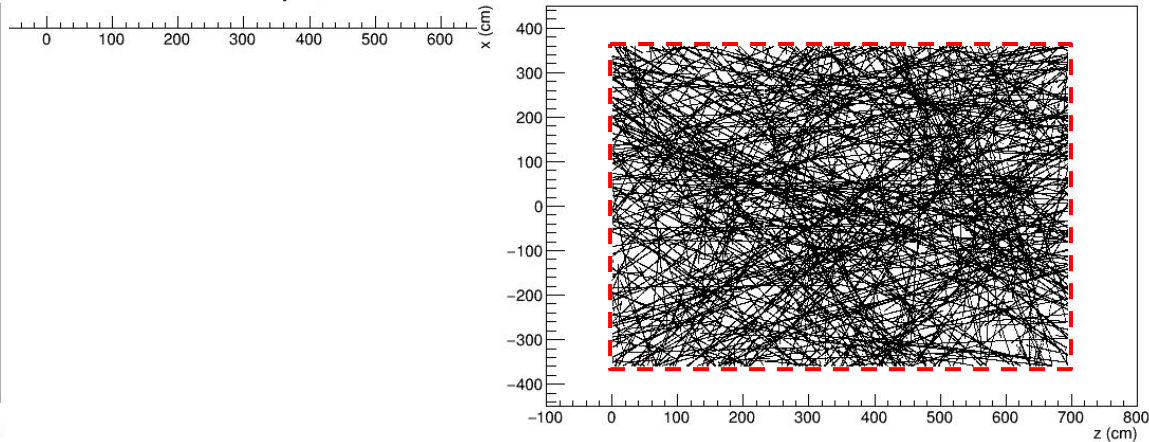
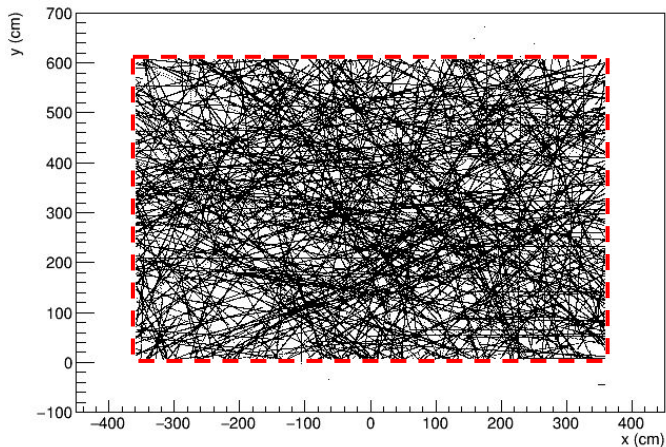
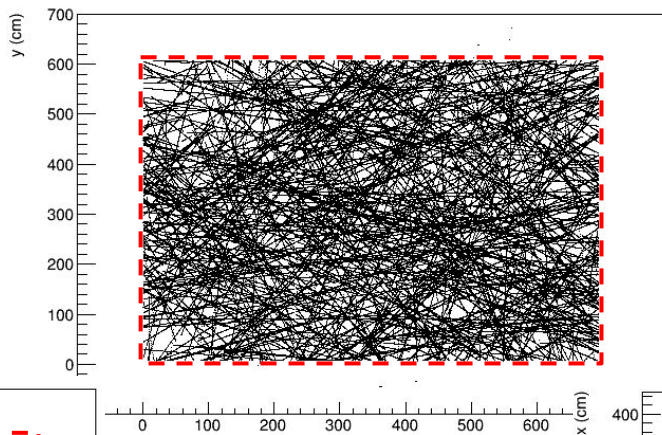
Validation of SCE correction using dE/dx

- Simulated 1000 isotropic, high-energy (1000 GeV), quiet muons to cover detector using dunetpc v08_15_01
 - Uniformity calibration turned off in reco
 - Electron lifetime set to 3 s
 - Used fluid flow maps in g4
- Compare 3 data sets with same gen stage:

Set	SCE simulated?	SCE calibration applied?	Data Product
1	No	No	pandoracali
2	Yes	No	pandoracali
3	Yes	Spatial only	pandoracaliSCE

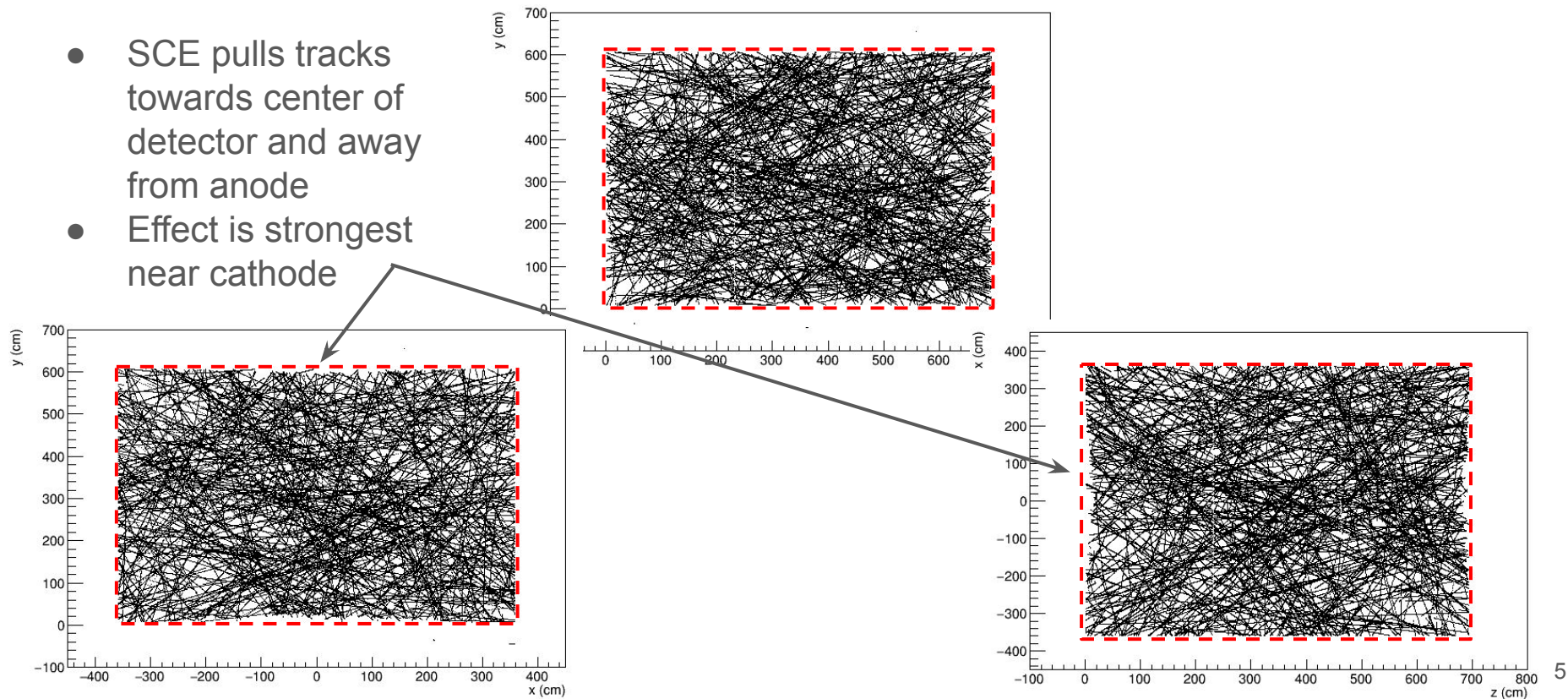
Coverage of the detector with no simulated SCE

- SCE pulls tracks towards center of detector and away from anode

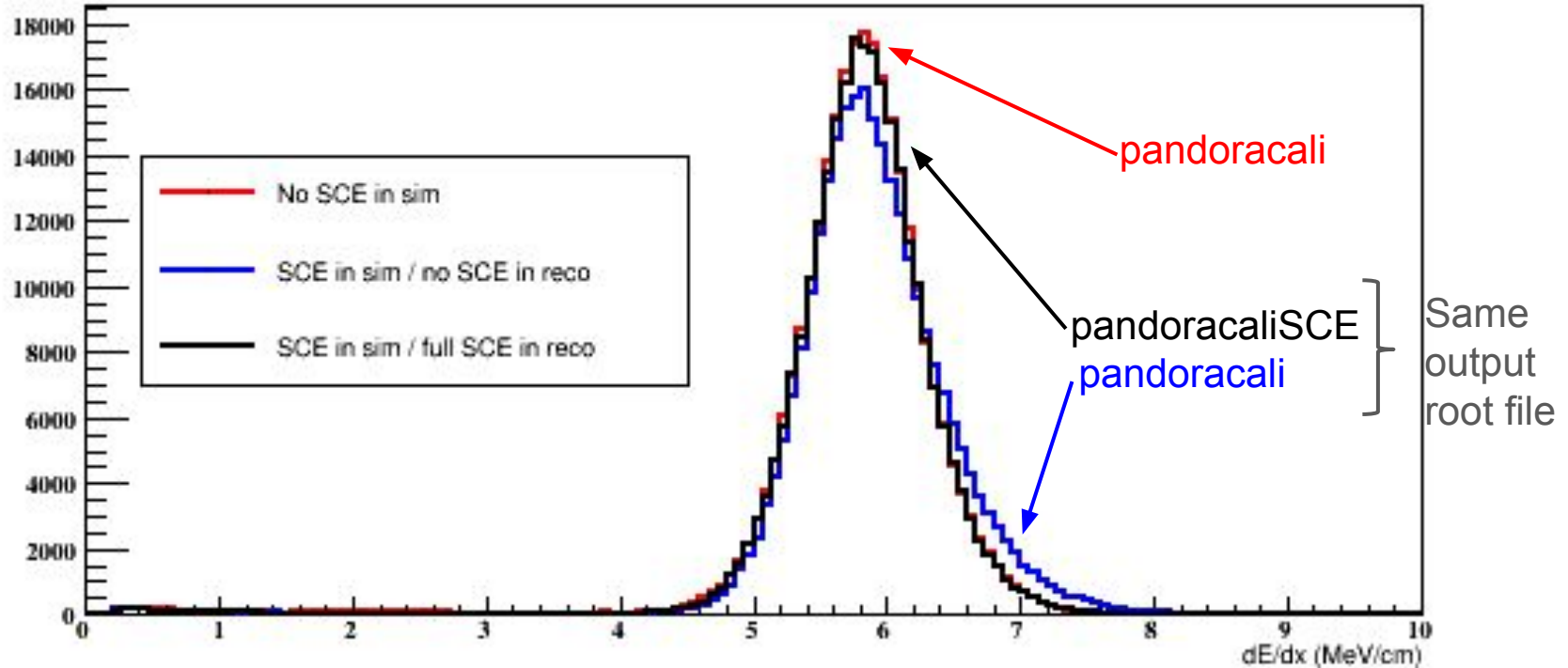


Coverage of the detector with simulated SCE

- SCE pulls tracks towards center of detector and away from anode
- Effect is strongest near cathode

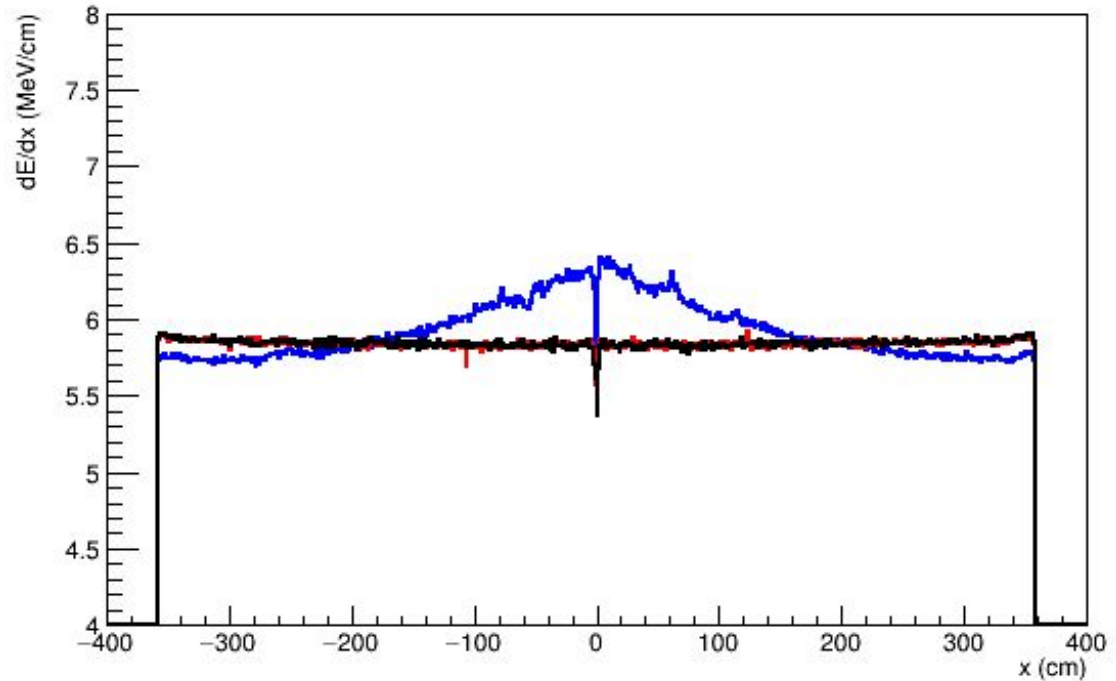


dE/dx comparison



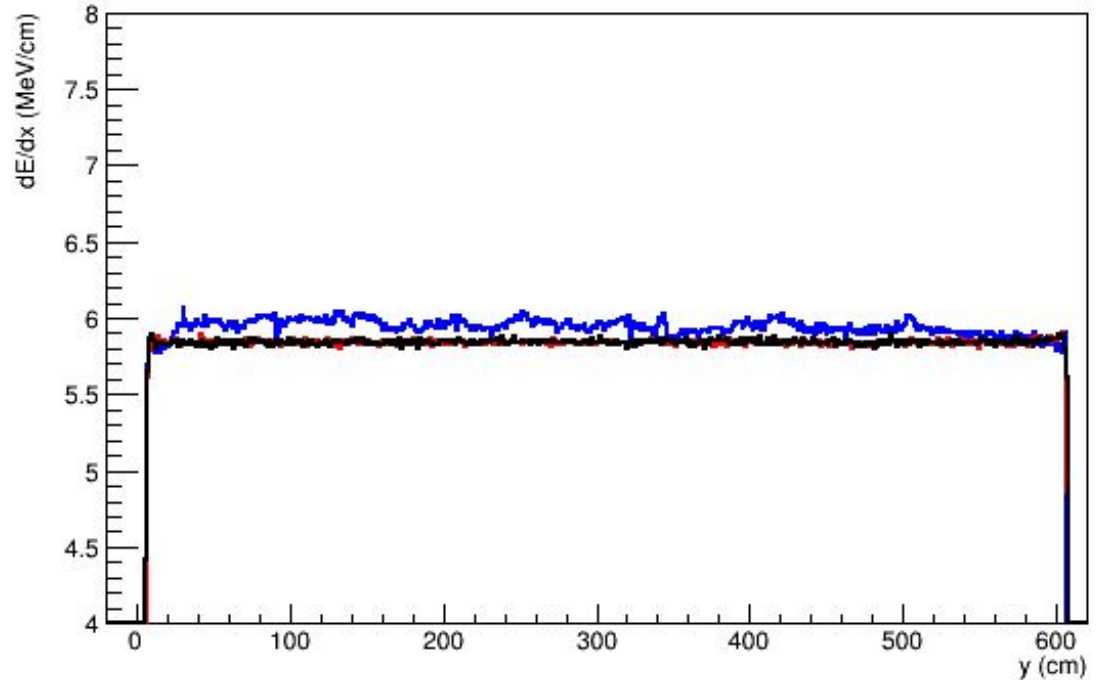
Location dependence of dE/dx SCE correction

- No SCE in simulation
- Simulated SCE with no SCE calibration
- Simulated SCE with full SCE calibration
- No location-dependent mismatch between no SCE and SCE calibrated dE/dx



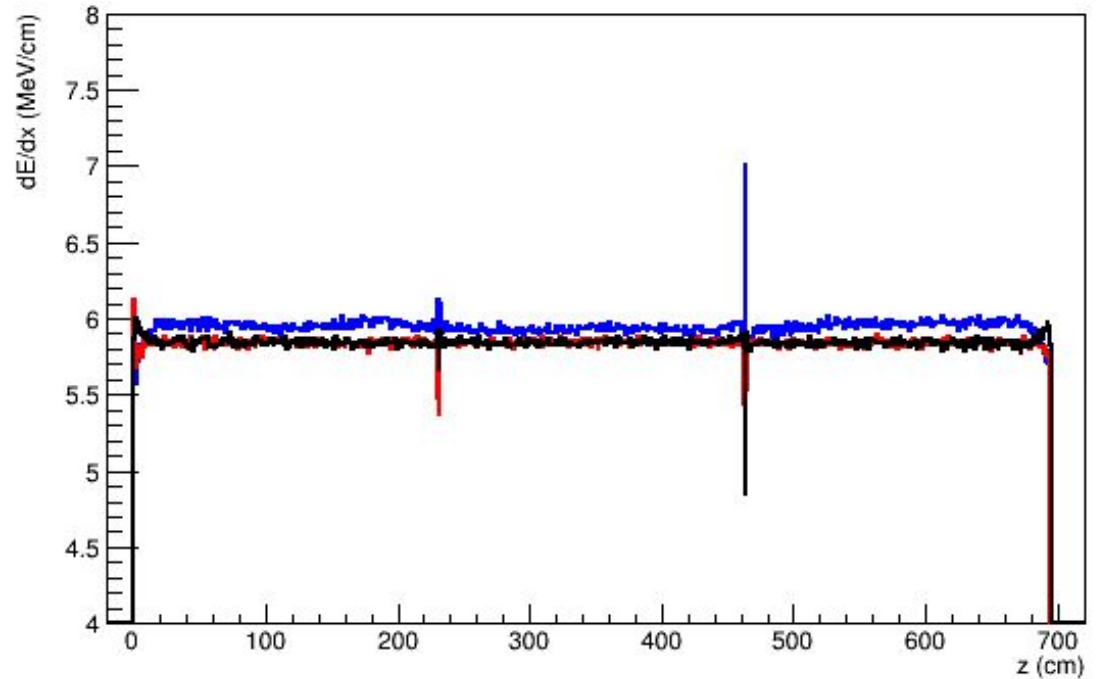
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Remaining Work

- Modify SpaceChargeService and calls to service to take in TPC information in order to
 1. Ignore charge in outer APAs
 2. Correct charge that appears past the cathode using the correct map

This requires a breaking change for LArSoft (LarReco)

8	9	10	11
4	5	6	7
0	1	2	3

