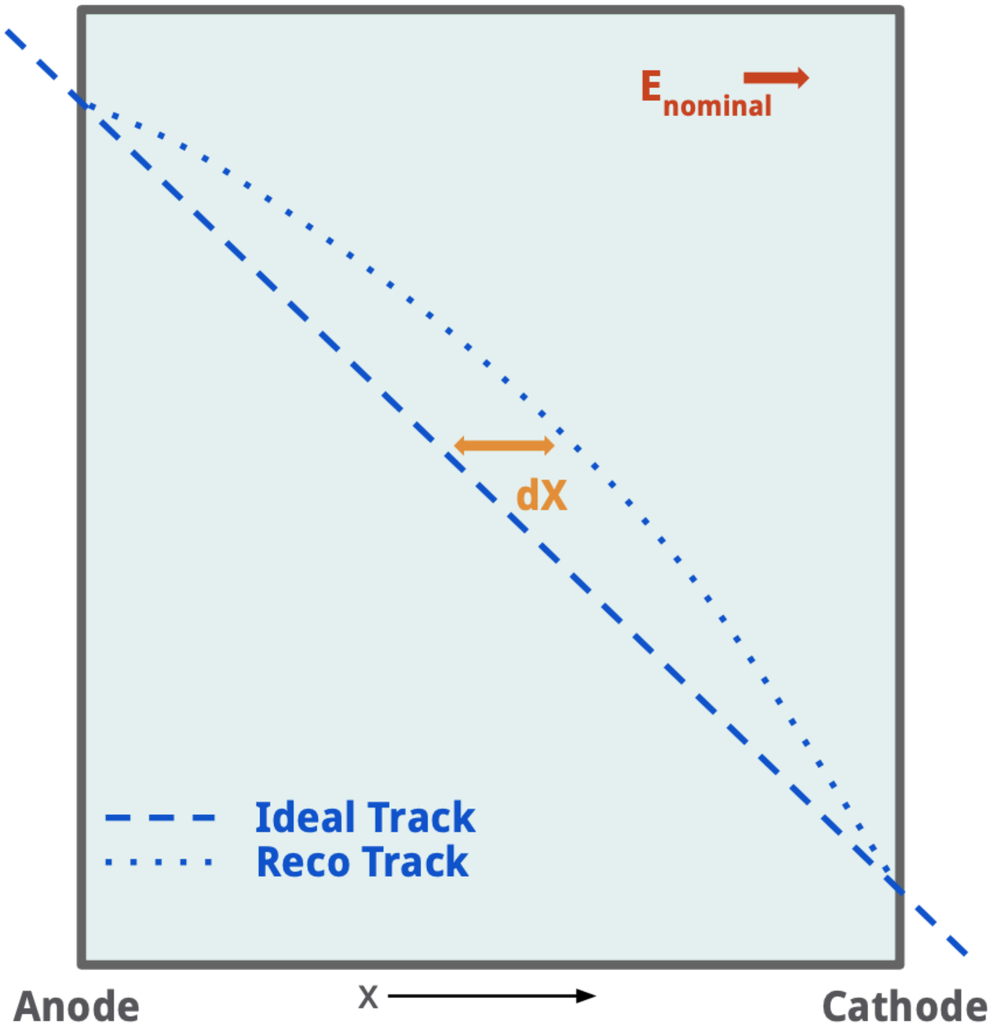
SCE Correction for SBND WirecellI

Avinay Bhat, Lynn Tung, Haiwang Yu
05/19/2026

Goal

- Space charge displaces reconstructed hits by up to ~1 cm
- WireCell's clustering depends on geometric consistency between wire planes
- An uncorrected drift coordinate distorts the 3-D point cloud
- SCE map is now applied at reconstruction time inside WireCell



Recap from Last Week

- apa0 East correction was already working
- apa1 West correction was previously zero
- New patches fix apa1 SCE application and empty-grouping crashes
- 50-event crossing-muon validation reproduces Lane’s W > E observation
- One remaining WCT question: apa1 face convention

What have I done since last presentation?

- apa0 / East TPC: SCE correction working
- apa1 / West TPC: SCE displacement was zero for every point
- Root cause: coordinate-frame mismatch
  - SCE map expects global X
  - apa1 points arrived in local TPC frame
- Result: map lookup clamped out / returned zero displacement
- Goal: patch apa1 and validate on crossing muons

Code Patches

- Patch 1: apa1 frame reflection
  - File: clus/src/PCTransforms.cxx
  - Detect local apa1 frame by bounding-box check
  - Reflect about anode: x_global = 2 × anode_x – x_local
  - Negate returned dx after reflection

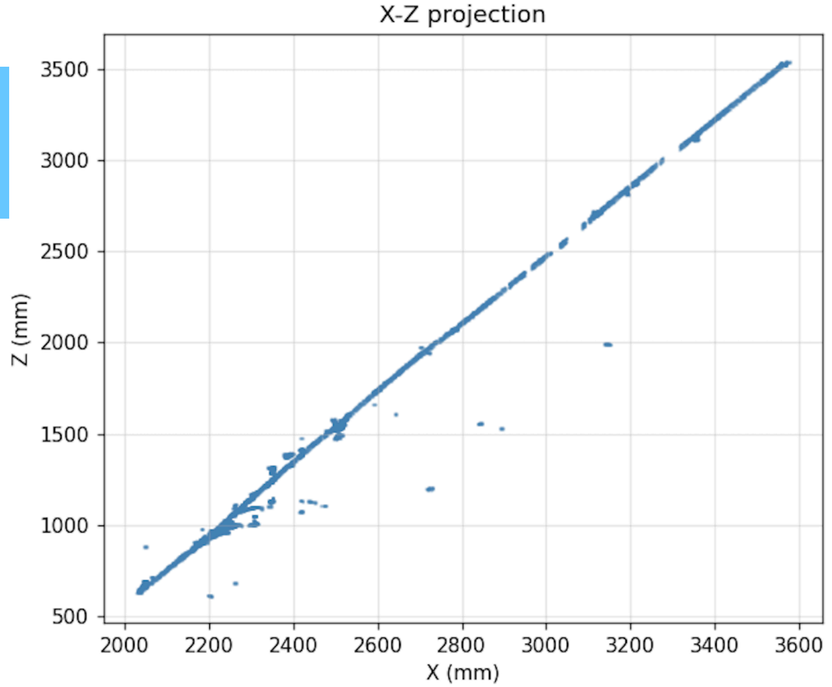
- Patch 2: empty-grouping handling
  - File: clus/src/clustering_switch_scope.cxx
  - Empty groupings are legitimate when a muon misses one TPC
  - Replace hard throw with early return + debug log
  - Recovered 16 previously crashing events
  - Added 15 valid West cluster events

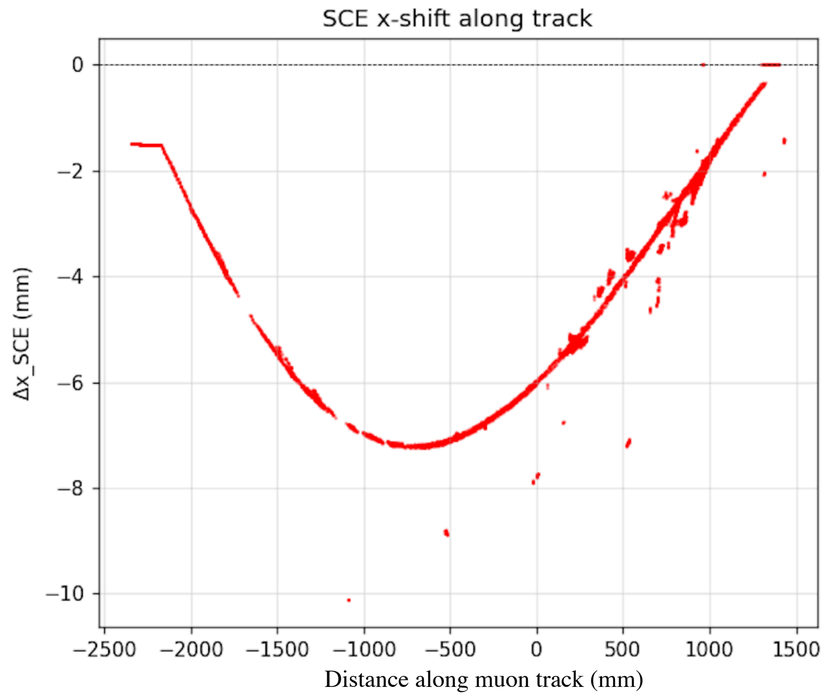
Validation Sample and Pipeline

- Generator: prodsingle_mu_3GeV_fixposapacross_gaus20degree.fcl
- 3 GeV μ^-
- Fixed start on cathode
- 20° Gaussian angular spread
- Full chain: GEN → G4 → DETSIM → WCT clustering
- Processed event-by-event through WCT
- Final valid clusters:
  - East: 30
  - West: 49
- Asymmetry expected: some muons miss one TPC

Single-Event Sanity Check

- Example: event 3, apa1 / West TPC
- ~4900 sampled points along one muon track
- Track angle: ~66° from X-axis
- Per-point SCE x-shift forms a smooth parabolic profile
- Peak shift: ~7.5 mm at mid-drift
- Shift approaches zero near anode and cathode
- This is the expected SCE behavior





Coordinate confusion

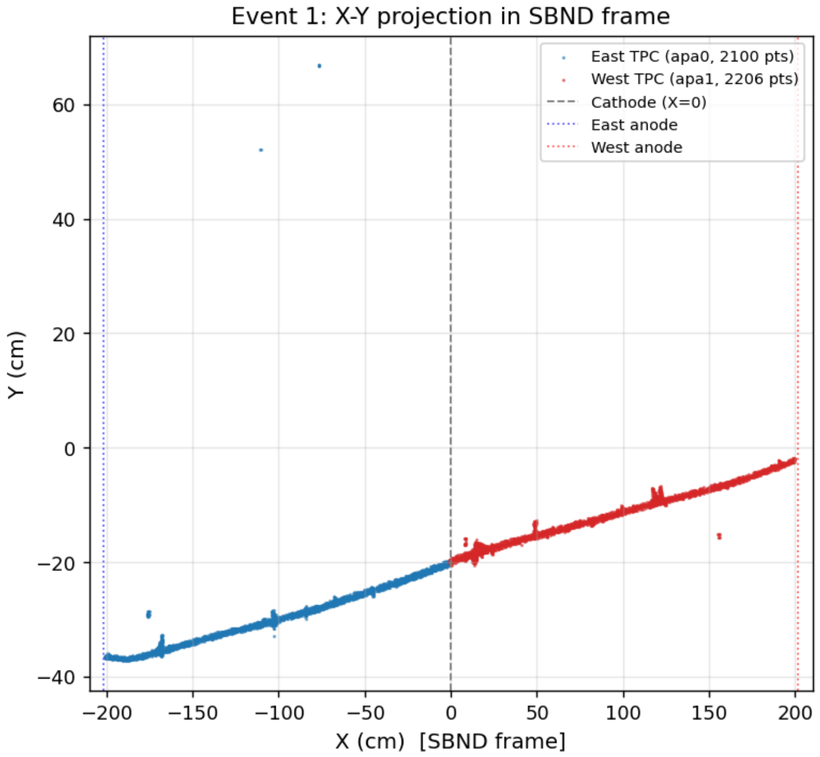
- X axis is in WCT's internal apa1 coordinate frame where the drift-time conversion uses drift_speed = -1.6 mm/μs (the negative sign was set for apa1).

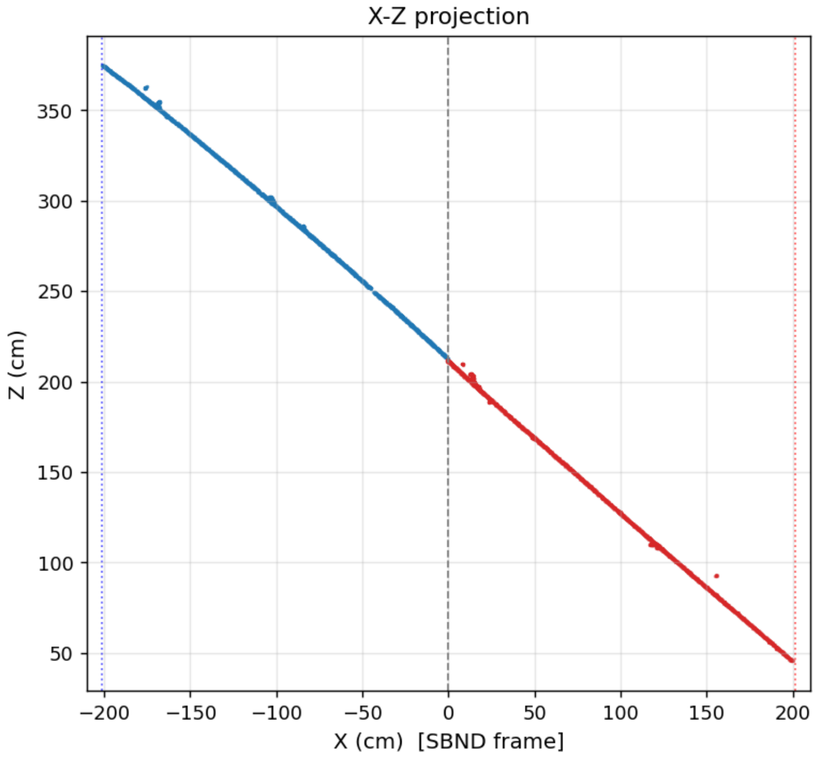
- WCT frame for apa1:
  - <AnodePlane:apa1> X planes: cathode@0.0045m, response@1.9205m, anode@2.0145m, dirx=-1

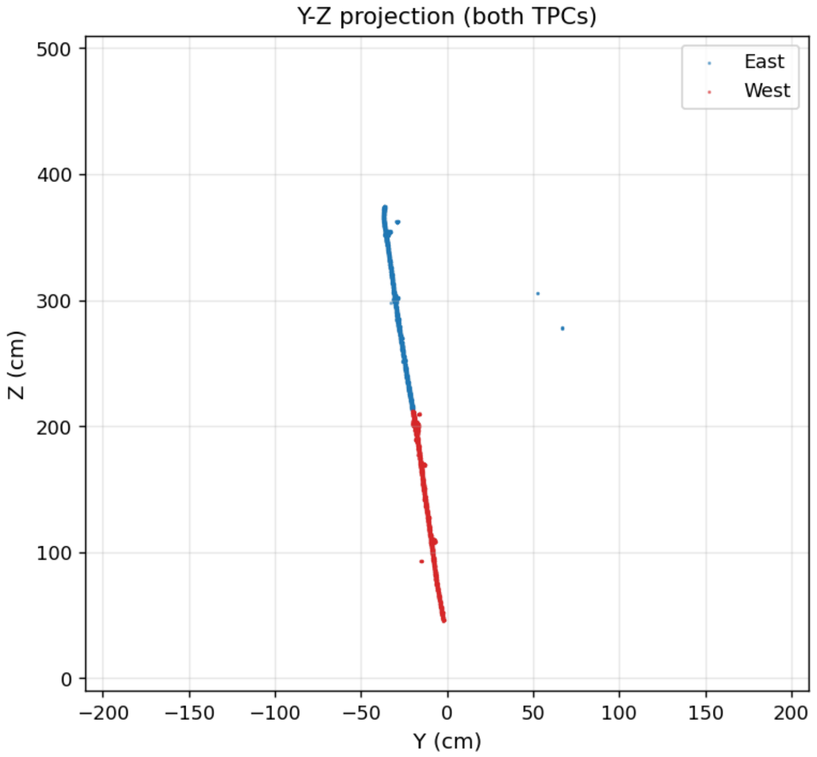
- BlobSampler computes the point X as: **X_point = anode_x - drift_speed × t**
  - With drift_speed = -1.6 mm/μs for apa1 (negative), this expands the drift time into +X
  - Anode → stays at X = 2014.5
  - Cathode → maps to X = 4024.5
  - Drift distance from anode = X_stored – 2014.5

Coordinate confusion

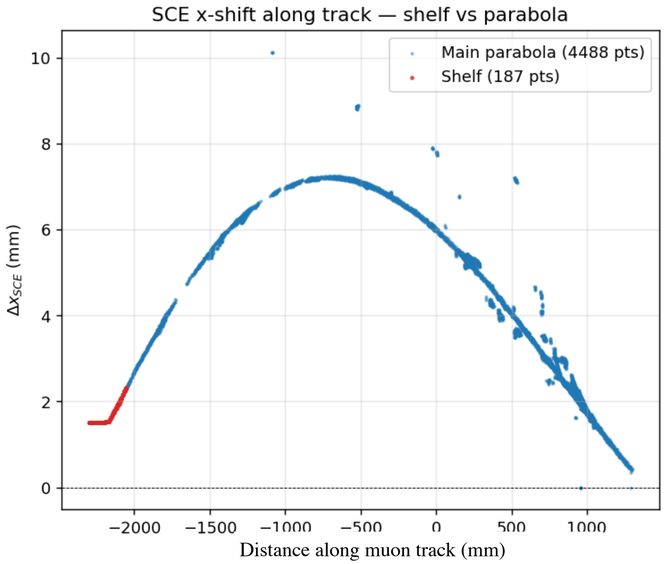
Cathode-crossing muon, event 1: continuous trajectory across both TPCs

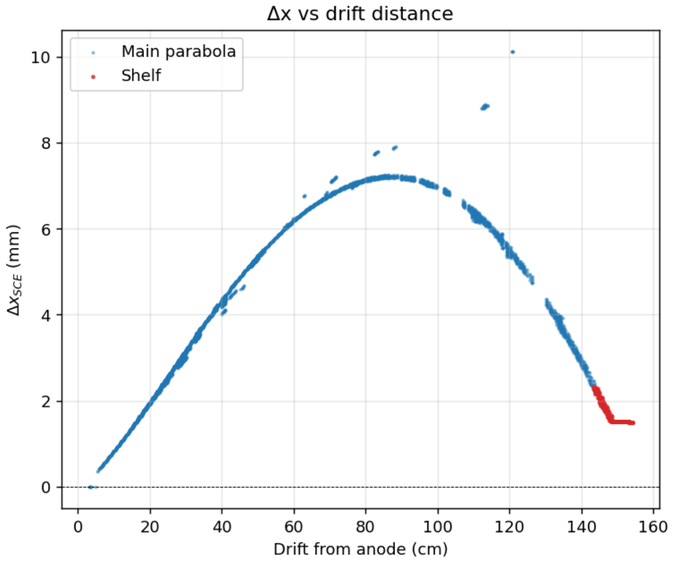


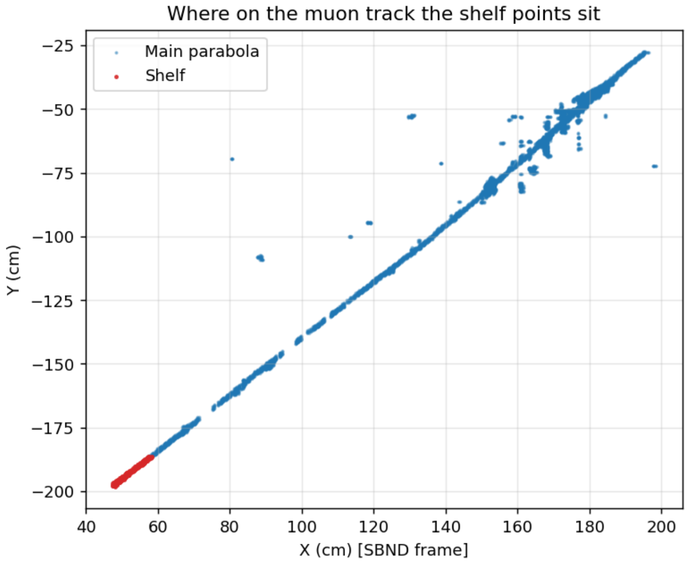




Shelf Question

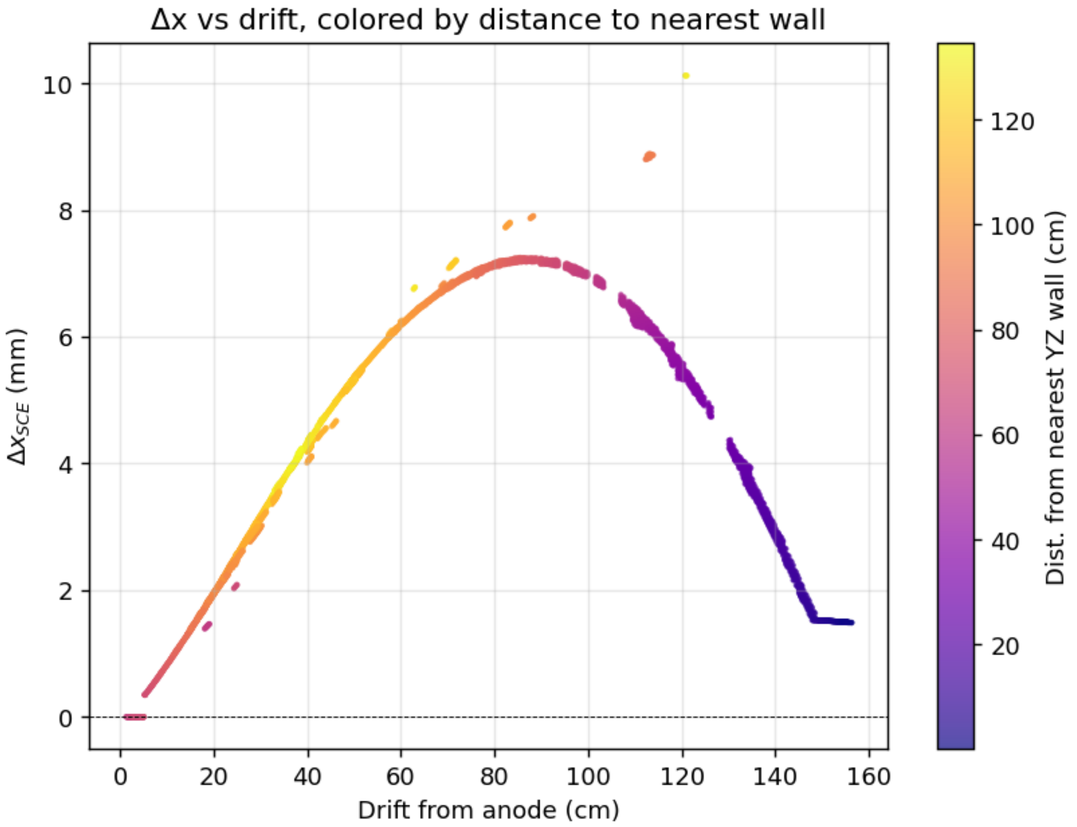


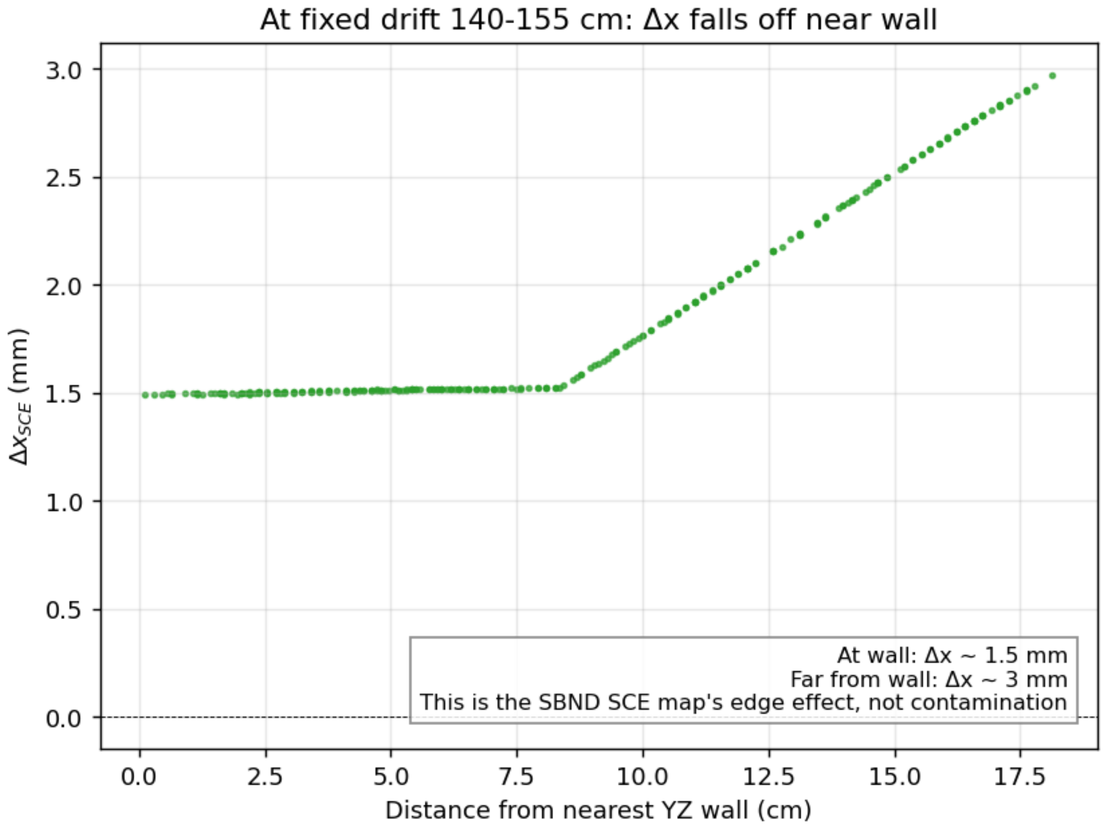




- The shelf is a feature of the SBND dualmap TH3, not our reconstruction. The track has a "shelf" only because it grazes the wall at the cathode-side end of its trajectory.

Shelf Question

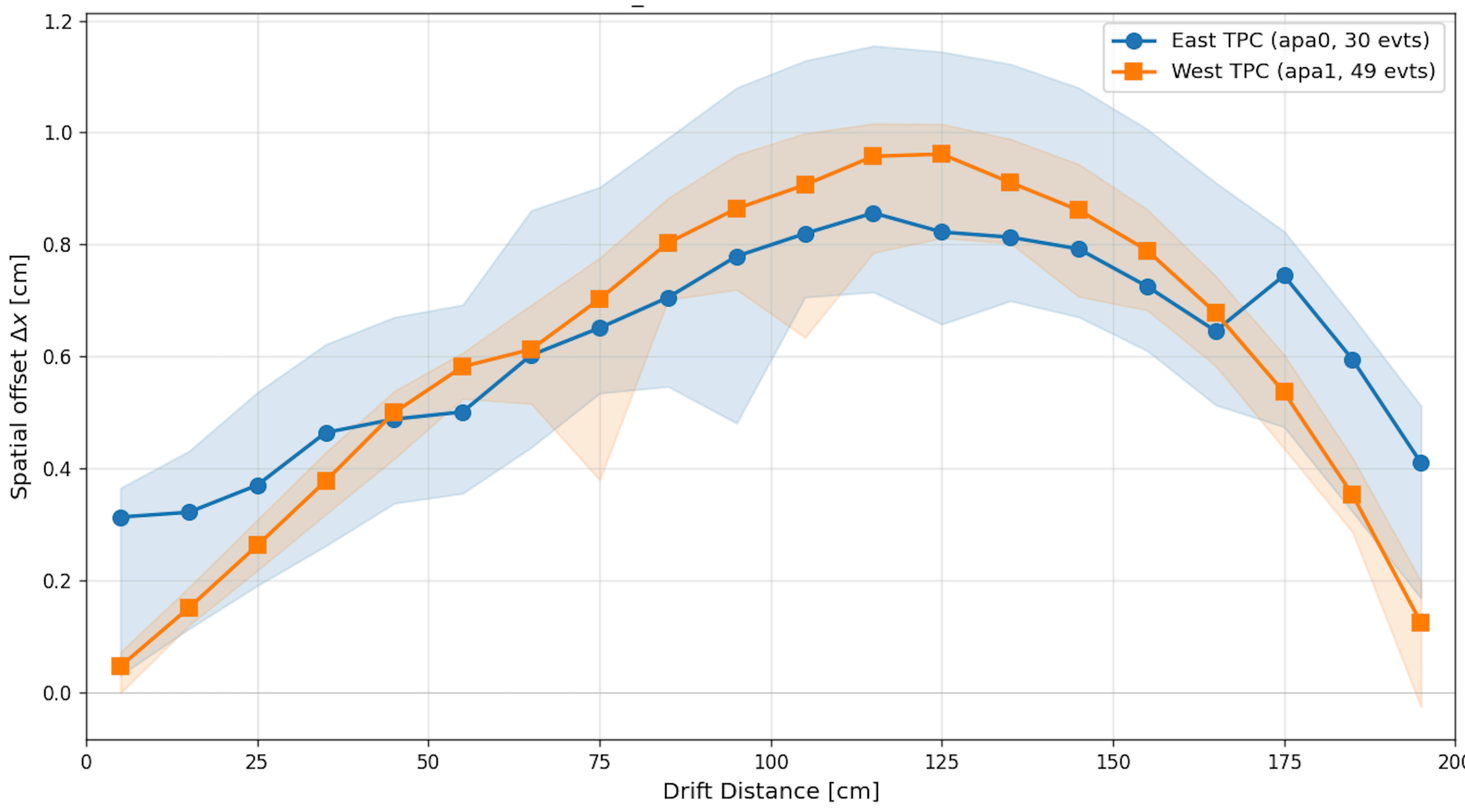




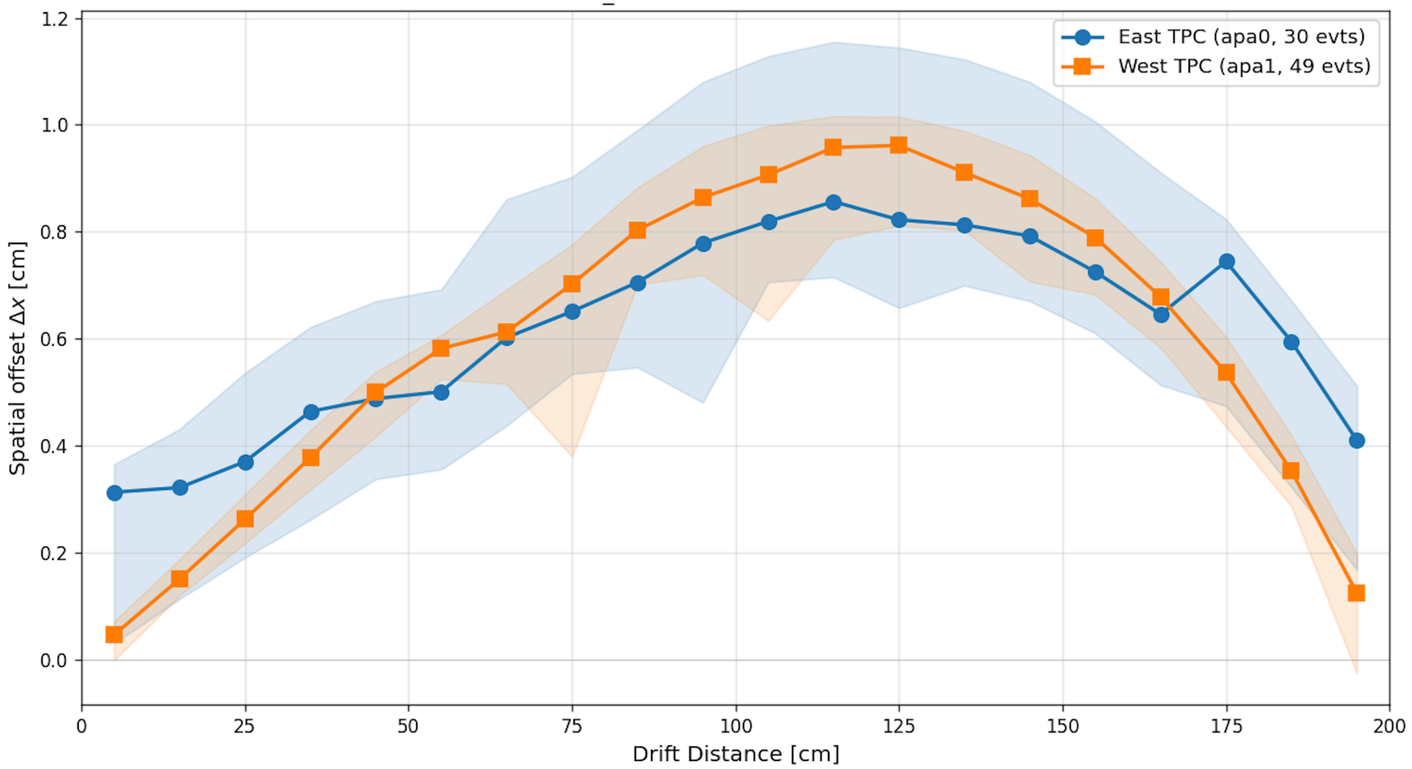
Result

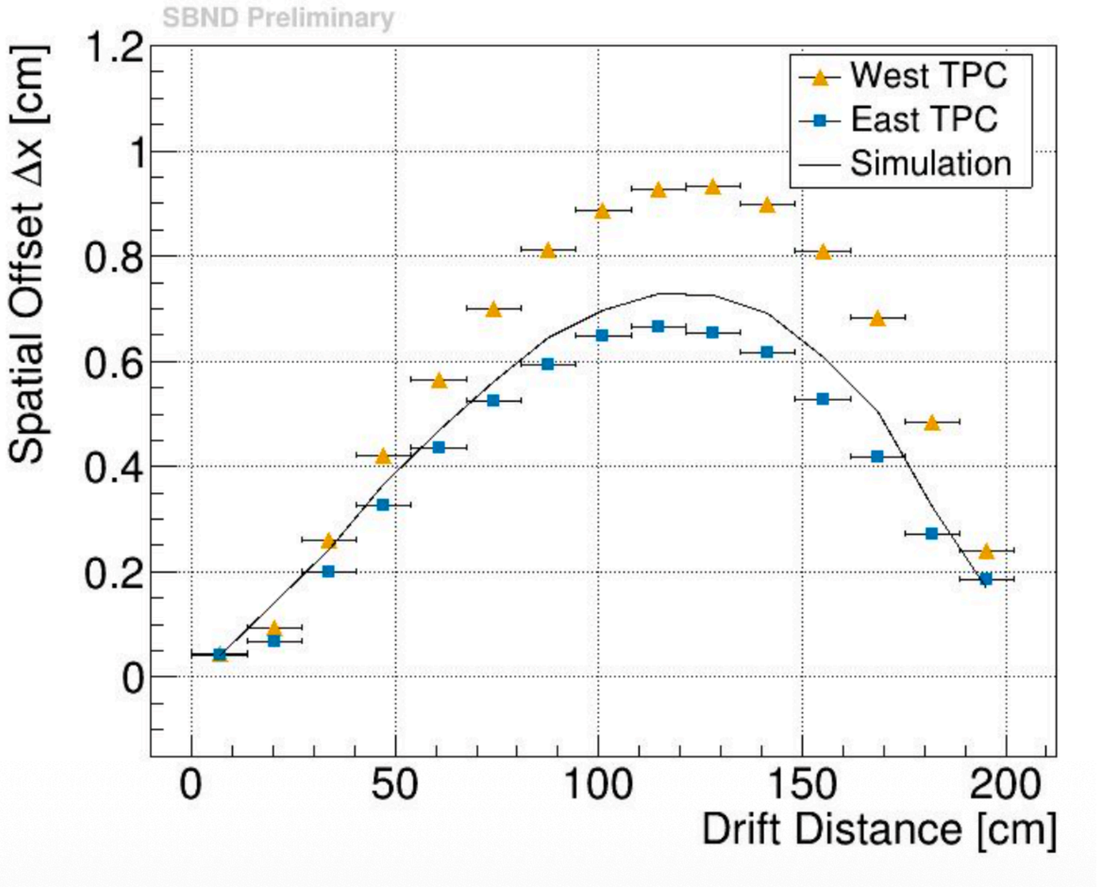
- Method
  - Lane original: line-fit residual between T0 and T0+SCE clusters
  - Lane-direct: per-point dx = x_t0cor – x_t0scecor
  - Bin per-point shift by drift distance
  - Average across events for each TPC

- Result
  - East peak: 0.86 cm at 115 cm drift
  - West peak: 0.96 cm at 125 cm drift
  - W > E across central drift region: 75–155 cm
  - Peak W/E ratio: 1.12–1.17
  - Central weighted-mean W/E: ~1.12



Comparison to Map and Lane's Previous Result





Open WCT Question, and Next Steps

- Validated
  - apa1 SCE correction is now nonzero, apa1 frame reflection works
  - dualmap routing verified: apa0 → East, apa1 → West
  - Empty-grouping fix recovered validation events
  - 50-event chain runs end-to-end, Lane-direct W > E confirmed
  - Single-event SCE profile is smooth and physical

- Open WCT question
  - apa1 clustering pipeline currently trimmed: 9 of 13 methods
  - Skipped: ClusteringConnect1, ClusteringDeghost, ClusteringExamineXBoundary, ClusteringIsolated
  - Geometry inconsistency:
    - AnodePlane:apa1.faces = [face0_data, null]
    - SBND clustering Jsonnet uses a1f1 / face 1
    - wire_direction(face=1, apa=1) returns (0,0,0) and can segfault
    - setting face 0 instead causes GridTiling "no such face: 0”

- Should apa1 define face 1, or should Jsonnet consistently use face 0?

Back Up Slides