



Wire-Cell ProtoDUNE Local Meeting

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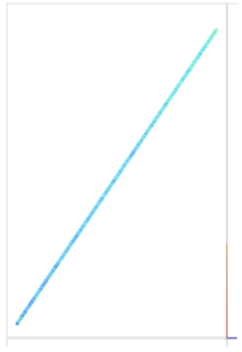
Wire-Cell 3D Imaging & Clustering

Performance Evaluation

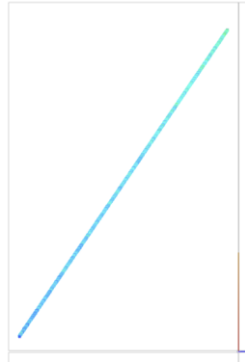
Current Status

- BlobDepoFill node -> Can extract true charges information in blobs

Reco blobs

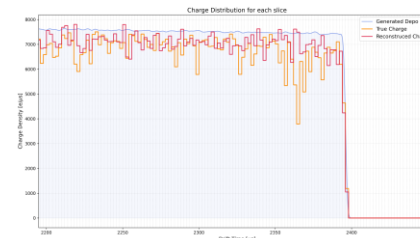
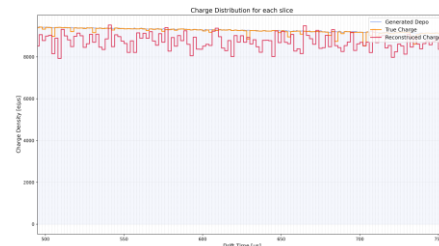
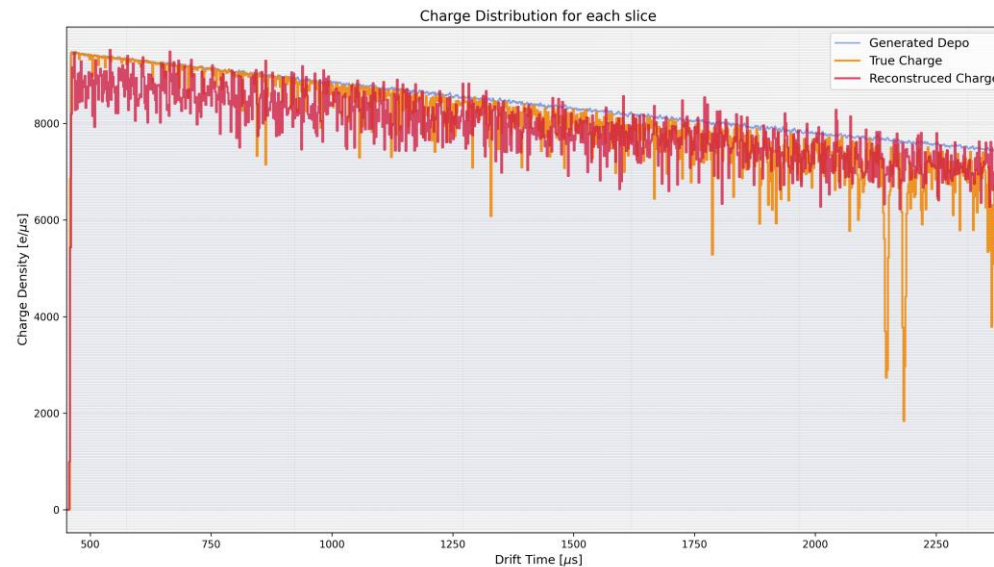


True Charge

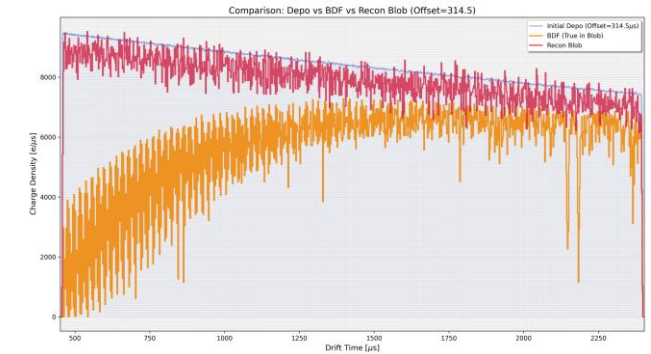


Drift

single long track (x : 10cm – 320cm)



ref) wrong ver

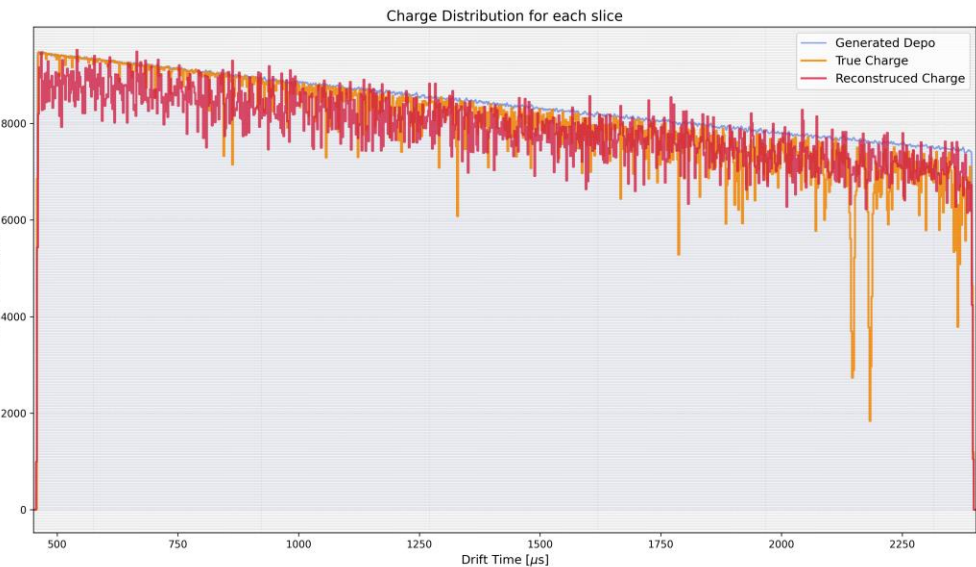


Wire-Cell 3D Imaging & Clustering

Performance Evaluation

Current Status

- BlobDepoFill node -> Can extract true charges information in blobs
- Using these information, defined purity and efficiency can be calculated.



$\text{Purity} = \frac{\text{Number of blobs with non-zero true charge}}{\text{Total number of reconstructed blobs}}$	
Total Reco Blobs	983
Blobs w/ True Charge(> 0.0)	983
FINAL PURITY	100.000000%
=====	

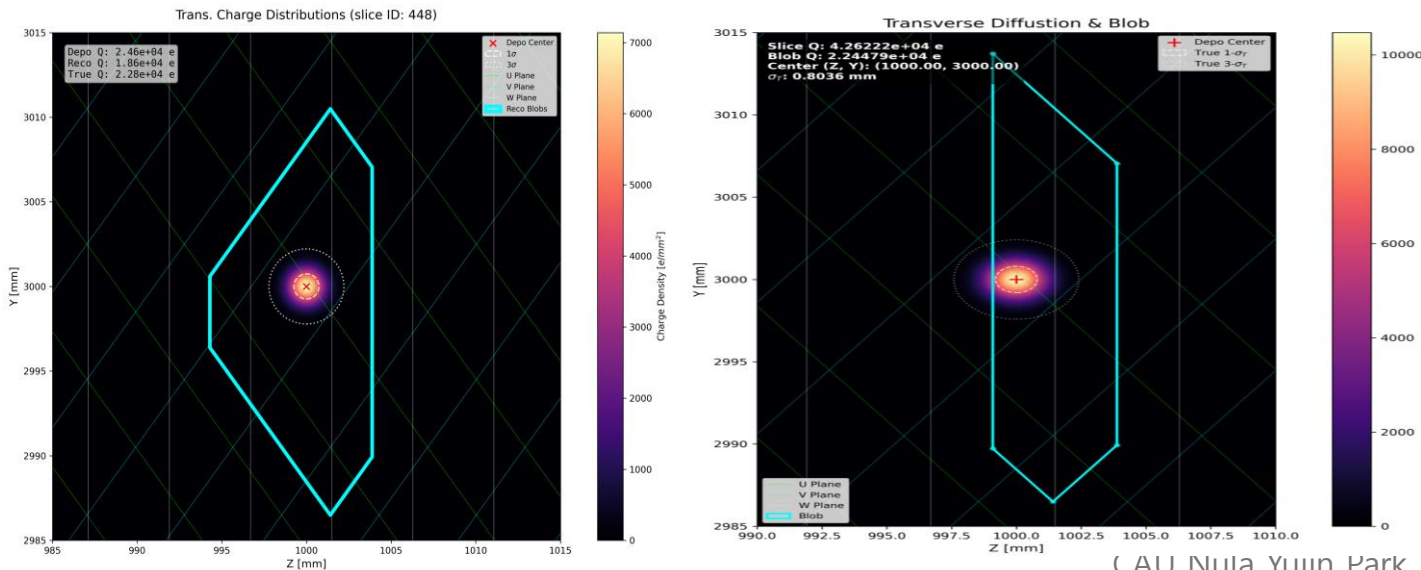
$\text{Efficiency} = \frac{\text{Total true charge in blob}}{\text{Total true charge}}$	
Total True Charge (Depos)	1.63e+07
True Charge in Blobs	1.56e+07
Lost True Charge	7.69e+05
FINAL EFFICIENCY	95.29%
=====	

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Performance Evaluation

Some Considerations

- In the current definition of purity, is non-zero true charge reasonable? (numerator)
 - Some threshold? (e.g. Counts blobs with charge above 50e-)
- Only charges in blobs are considered now.
 - Some inevitable charge losses -> Limits on charge evaluation.
 - Rather than charge evaluation, use for spatial evaluation? (Check spatial alignments)
- If a blob is reconstructed largely, Could it be evaluated? (Blob size)
 - Charge density indicate blob size



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$$\text{Purity} = \frac{\text{Number of blobs with non-zero true charge}}{\text{Total number of reconstructed blobs}}$$

$$\text{Efficiency} = \frac{\text{Total true charge in blob}}{\text{Total true charge}}$$



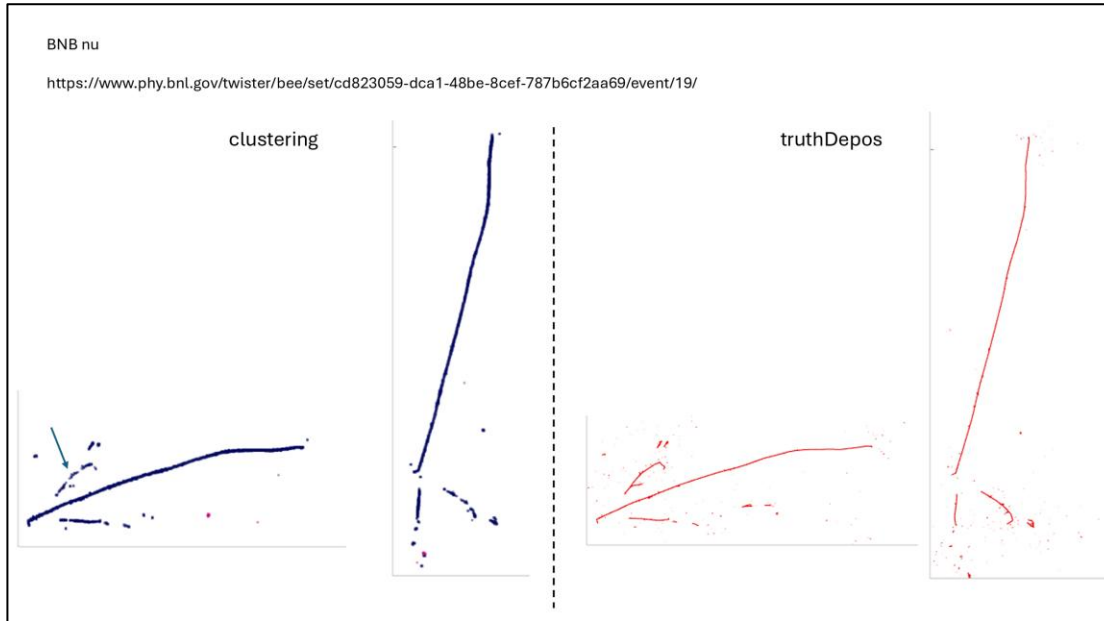
Charge Density?

Wire-Cell 3D Imaging & Clustering

My Evaluate Strategies(Idea/Plan)

Prepare Evaluation Target events

- *Clustering evaluation tools(WC general meeting - Jan30 2025 - Ewerton)*
- *First-pass clustering evaluation in SBND(WC general meeting - Mar20 2025 - Ewerton)*



- In SBND, they generated true depos and compared with reconstruction result directly
- This method can evaluate more realistic and complicated topologies.
- Some technical difficulties can be arisen
- Simpler method?
 - Woodpecker can be used?
 - From raw data, simulate simple track events
 - Calculate metrics for each tracks

Credit: Xuyang(Mar25, 2026)

Build a toolkit: [Woodpecker](#)

Larsoft part: run on gpvm

Noise filter + signal processing

pdvd/wcls-nf-sp-out.jsonnet

output files: .npy; contains raw; gauss; wiener

[Woodpecker](#)

Typical workflow

protodune-sp-frames-anode<N>.tar.bz2 (WireCell FrameFileSink output)

woodpecker select → masked anode<N>.tar.bz2 in woodpecker_data/

woodpecker run-img → imaging clusters in woodpecker_data/

woodpecker run-clustering → bee upload.zip + tracks-*.json in woodpecker_data/

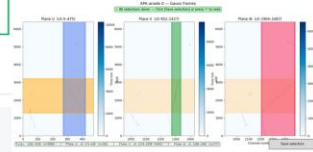
woodpecker extract-tracks → inspect track list

woodpecker run-sim-check → simulated raw frames (longest track)

woodpecker_data/protodune-sp-frames-sim-anode<N>

woodpecker plot-frames → U/V/W wire-plane image (PNG)

TBD: compare data and simulation



run wire-cell img+cluster

Extract track info

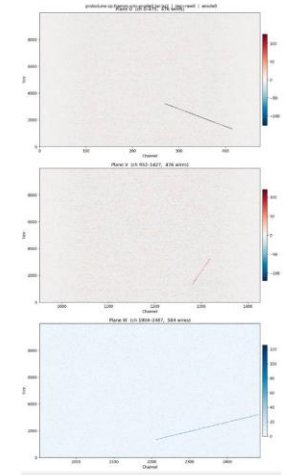
run wire-cell simulation

Plot

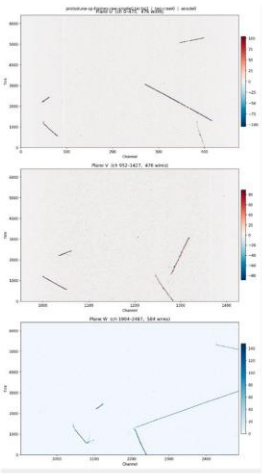
Extracted track info

```
{
  "cluster_id": 3,
  "n_points": 468,
  "source_file": "data/0/0-clustering-spa0-face0.json",
  "total_charge": 8861678.0,
  "centroid": [
    -195.3825368107422,
    -76.98346718205078,
    87.11829833964375
  ],
  "direction": [
    0.686181496219635,
    -4.2324043393468568,
    0.6893556118811475
  ],
  "length_cm": 282.375,
  "start": [
    -274.3976444296875,
    -58.181068420418156,
    7.848045349121894
  ],
  "end": [
    -135.5478515625,
    -87.2211689921875,
    147.3563993361328
  ],
  "linearity": 0.999896,
  "theta_deg": 46.4289,
  "phi_deg": -18.7156
},
```

Simulation



Raw data



Wire-Cell 3D Imaging & Clustering

My Evaluate Strategies(Idea/Plan)

Step 2) Spatial Evaluation

Evaluate the accuracy of the 3D spatial reconstruction by analyzing the size, position, and geometric alignment of each blob within an event.

- Quantify the reconstruction performance using **Purity and Efficiency metrics** to evaluate geometry cleanliness and spatial coverage
- Group the sub-events/blobs into **"Good"** and **"Bad"** categories based on established Purity and Efficiency thresholds (e.g., > 0.8).
- Only the "Good" group passes through to the subsequent De-ghosting and Charge evaluation stages.

Step 3) Ghost Discrimination and De-ghosting Algorithms Evaluation

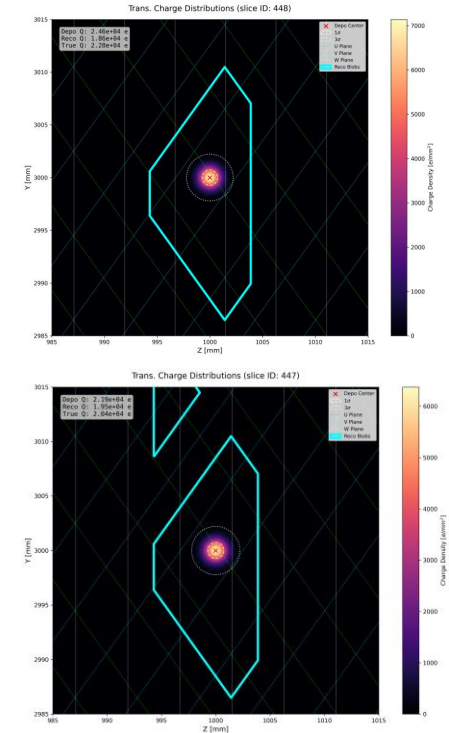
Evaluate the performance of the de-ghosting algorithm by quantifying its capacity to eliminate ghosts while preserving genuine signals.

- Quantify pure ghost rejection and check true signal preservation before/after de-ghosting.

Step 4) Charge Evaluation

Perform a pure charge evaluation exclusively on the refined, well-deghosted blobs that survived the previous spatial cuts.

- Use similar concepts of charge bias and charge resolution in the signal processing.



Backup