

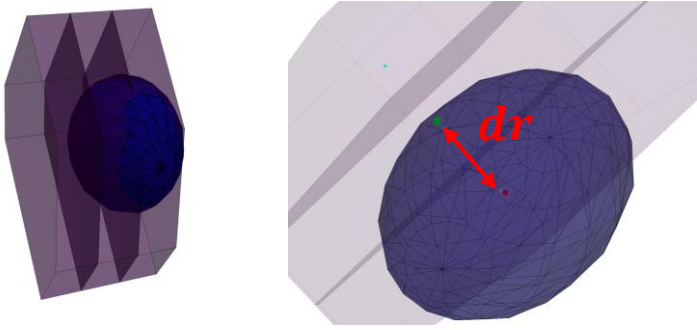


Wire-Cell ProtoDUNE Local Meeting

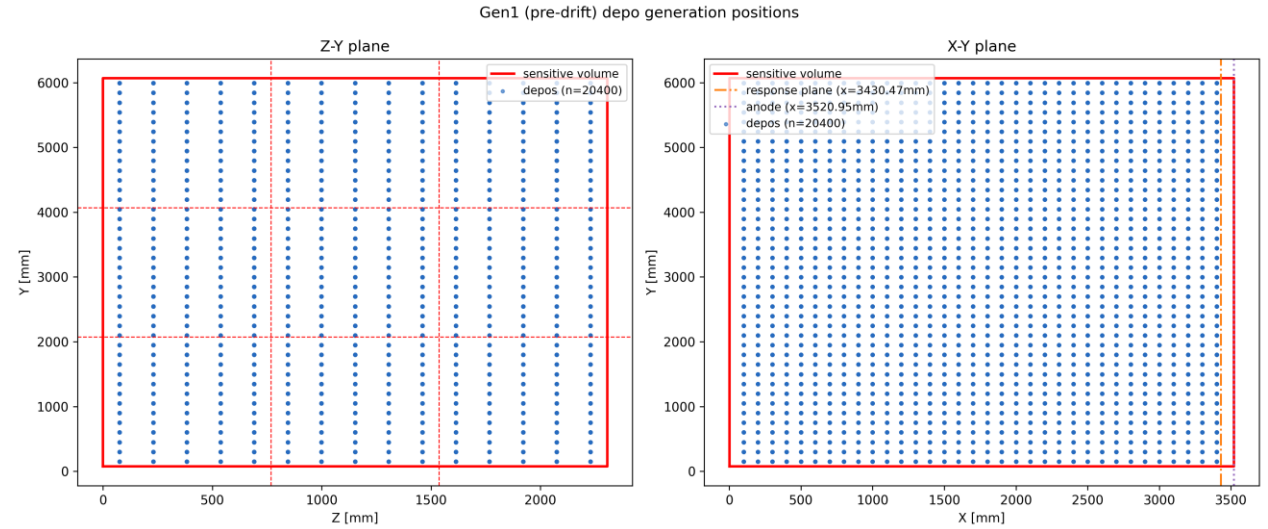
Yujin Park
Chung-Ang University
Jul29, 2026 (Wed)

Wire-Cell 3D Imaging

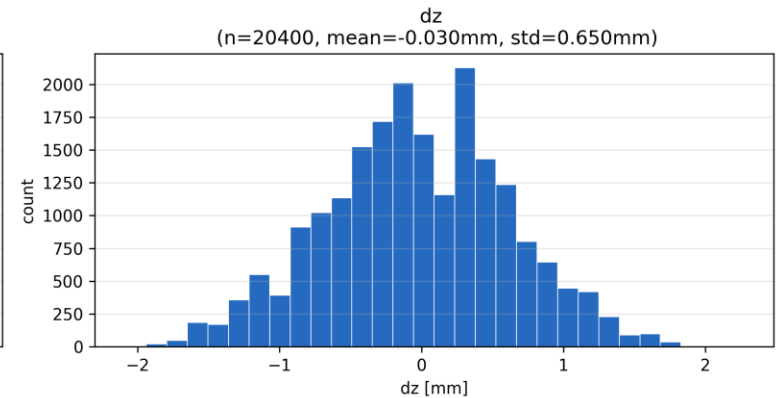
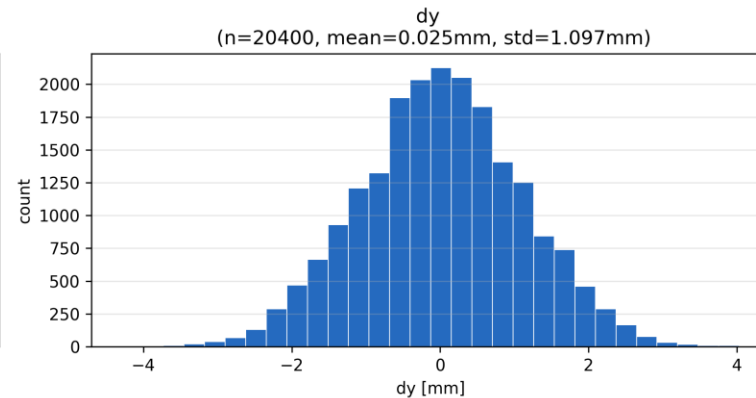
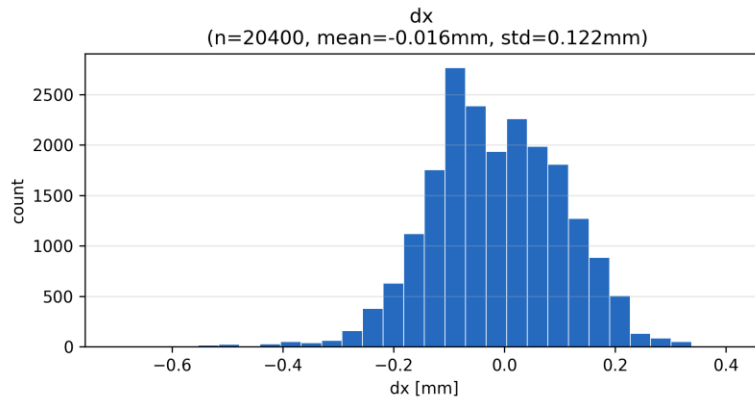
Depo-Blob Center Comparison



- 20400 point depos in PDHD APA2
- Uniform grid in the detector volume
- dx, dy, dz = blob's charge weighted center – depo center

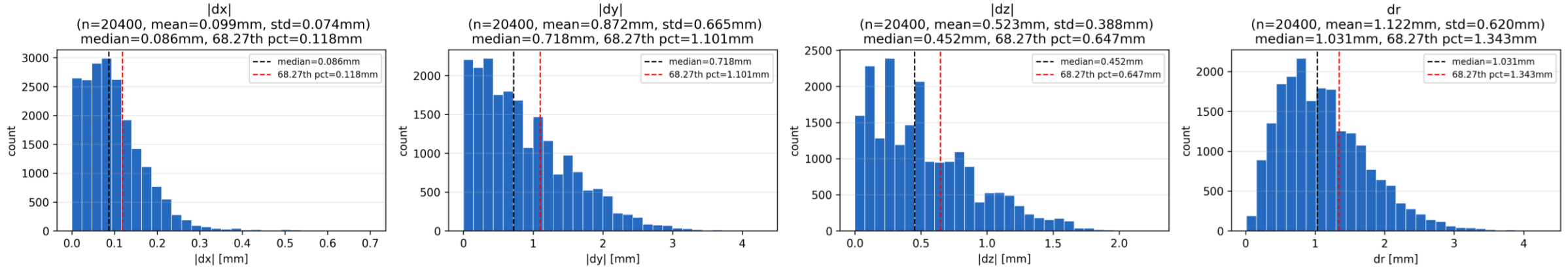


Depo center vs. charge-weighted blob center



Wire-Cell 3D Imaging

Depo-Blob Center Comparison



	Median	68.27% Percentile
x [mm]	0.086	0.118
y [mm]	0.718	1.101
z [mm]	0.452	0.647
r [mm]	1.031	1.343

- Measurements along the y-axis were relatively larger than the other axes, by about 1 to 3 cm.
- In dr, a peak was observed around 1 cm.
- The worst 10% within the dr distribution was classified as outliers. (2040 sample)
- The 50 worst samples were visually inspected.

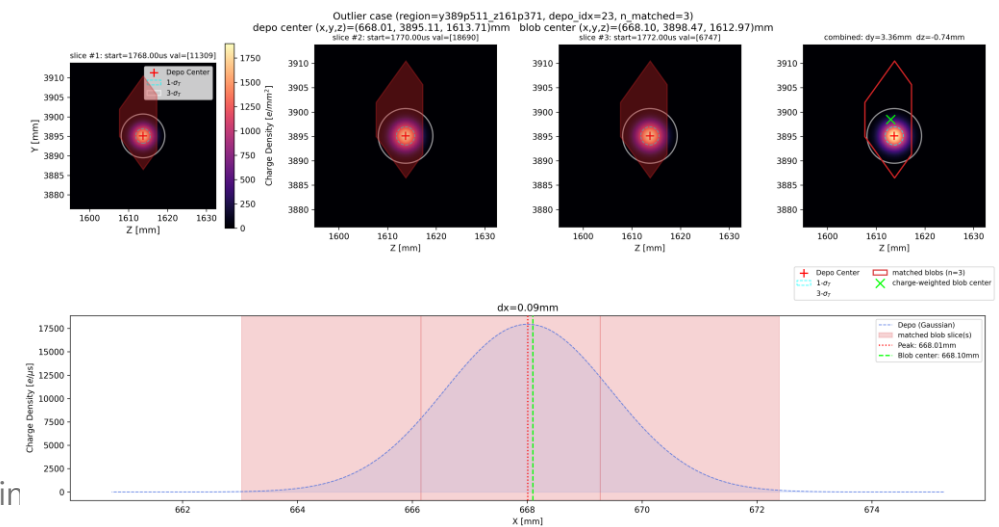
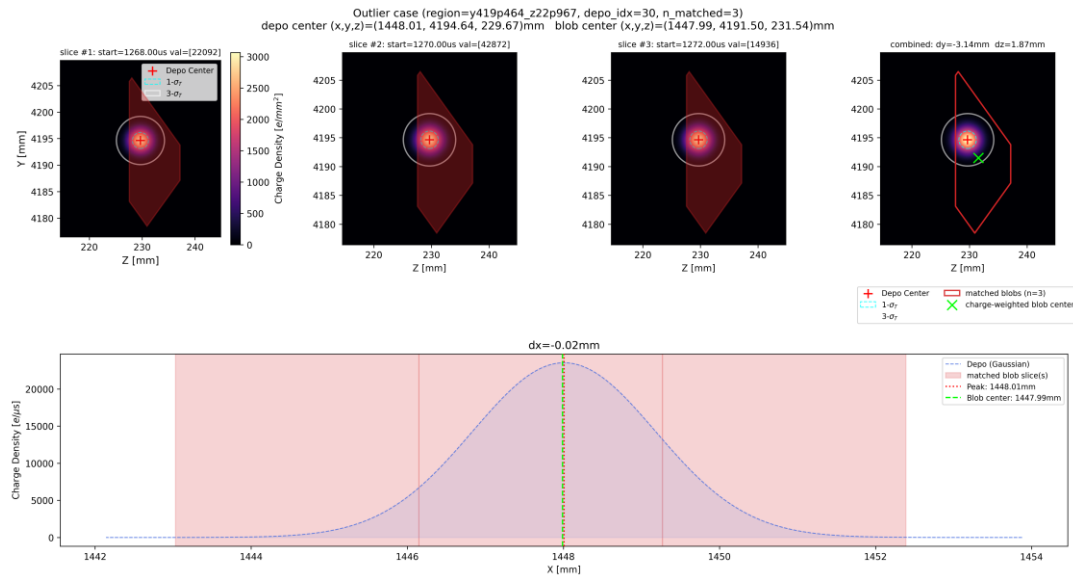
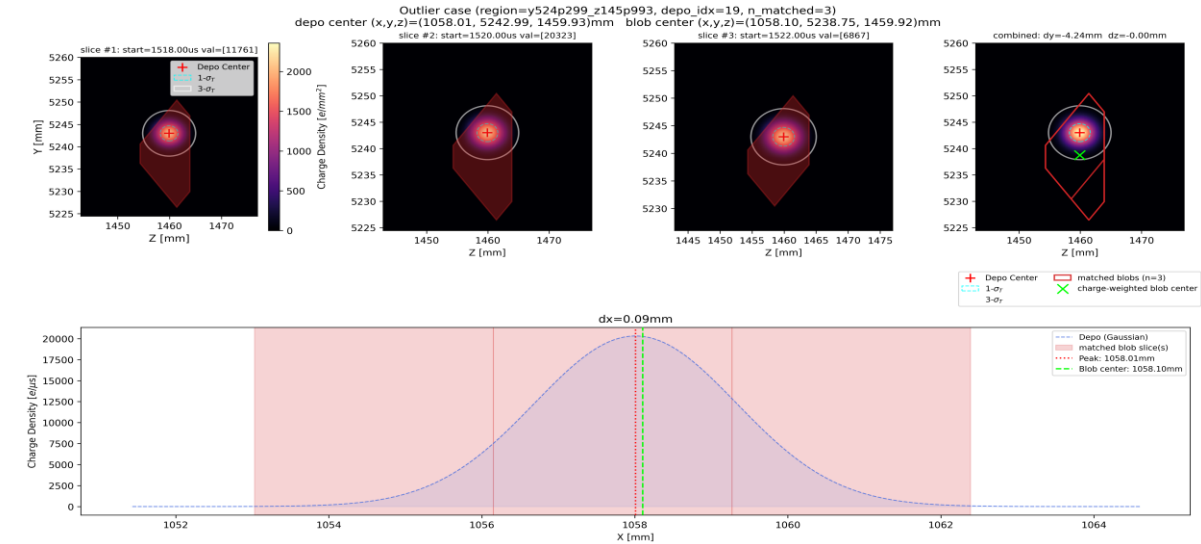
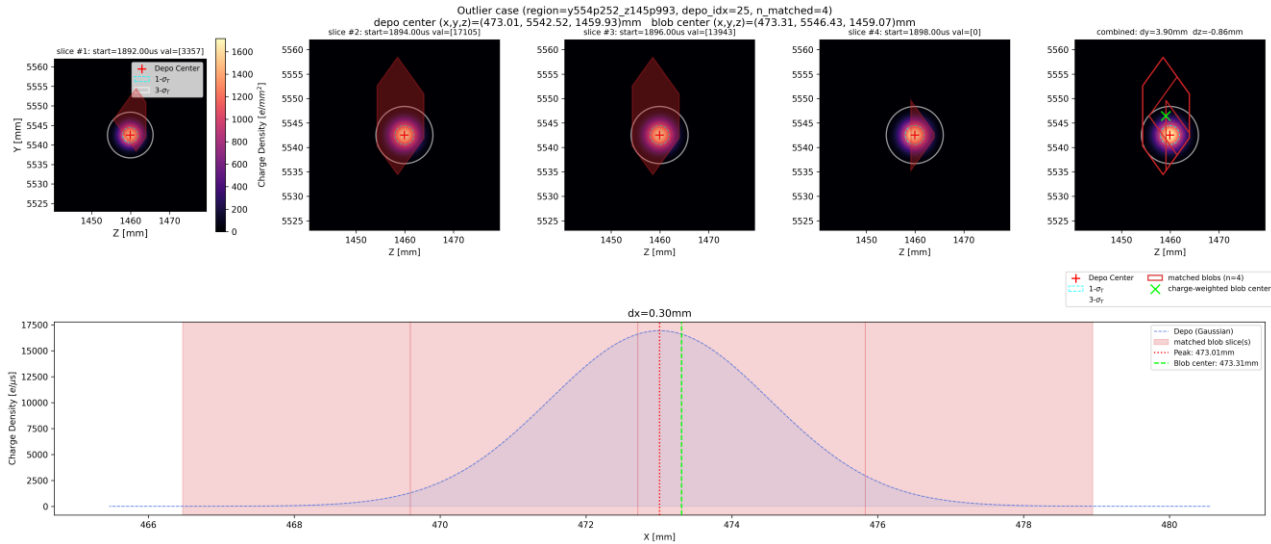
Outlier cases:

- 1) The blob sufficiently includes the depo, but there is a large center mismatch.
- 2) The blob fails to sufficiently cover the depo, and there is a large center mismatch.
- 3) The blob contains depo, but the blob size is large.

Wire-Cell 3D Imaging

Depo-Blob Center Comparison

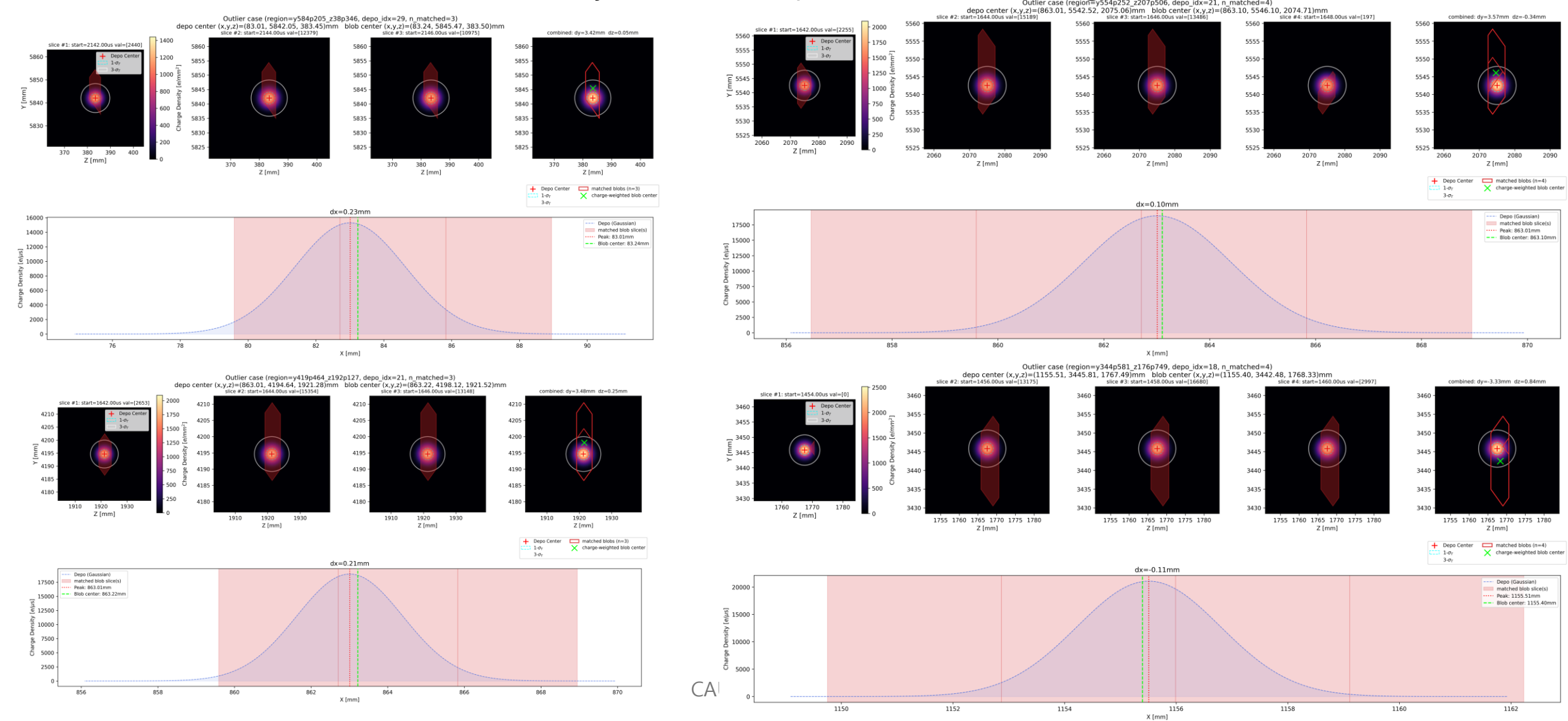
Outlier Case 1) The blob sufficiently includes the depo, but there is a large center mismatch.



Wire-Cell 3D Imaging

Depo-Blob Center Comparison

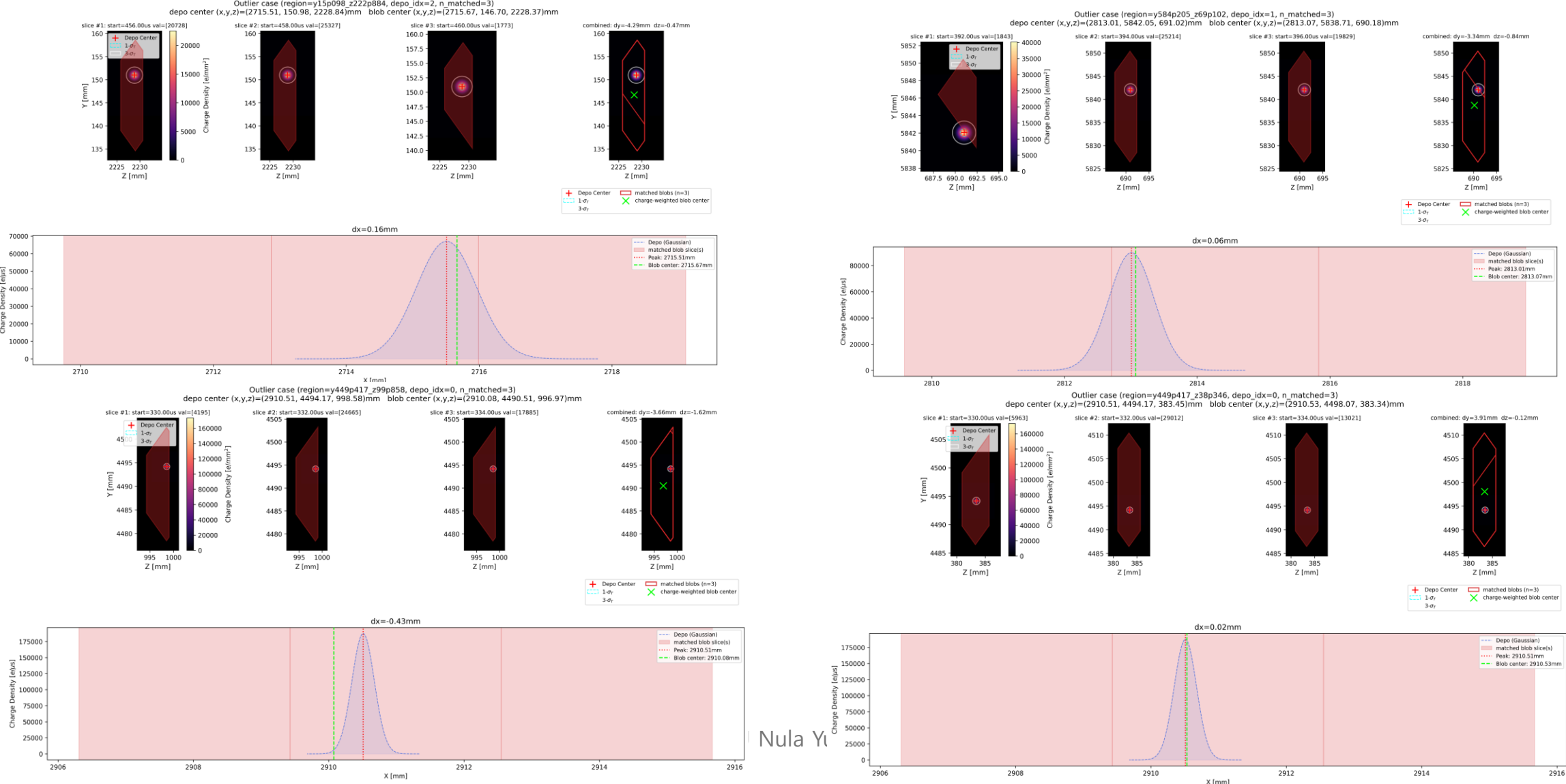
Outlier Case 2) The blob fails to sufficiently cover the depo, and there is a large center mismatch.



Wire-Cell 3D Imaging

Depo-Blob Center Comparison

Outlier Case 3) The blob contains depo, but the blob size is large.

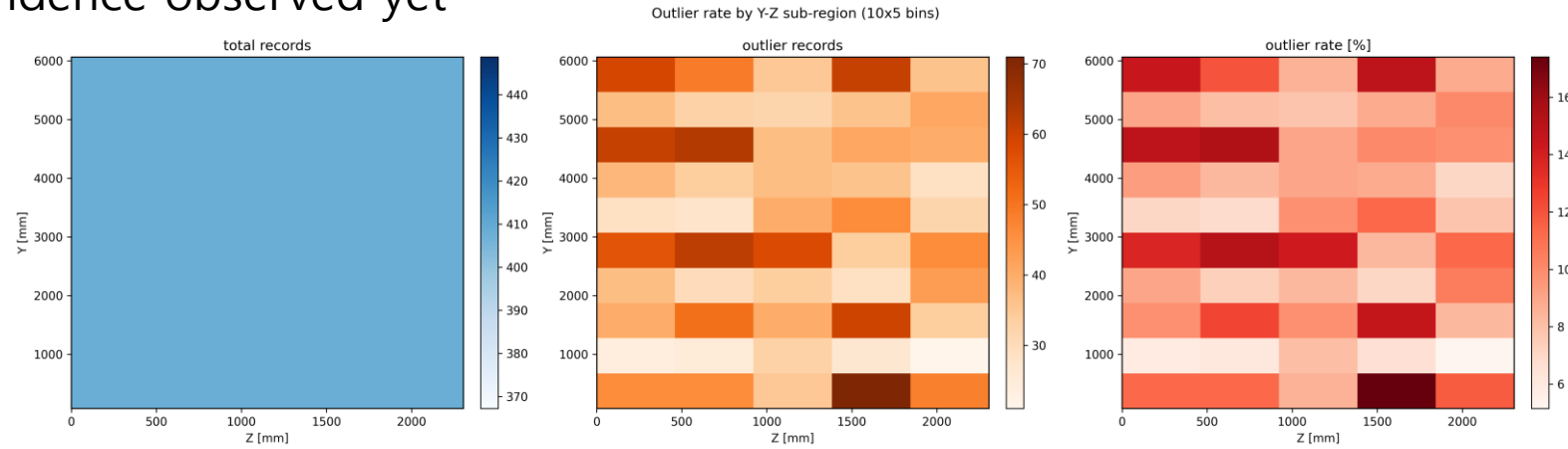


Wire-Cell 3D Imaging

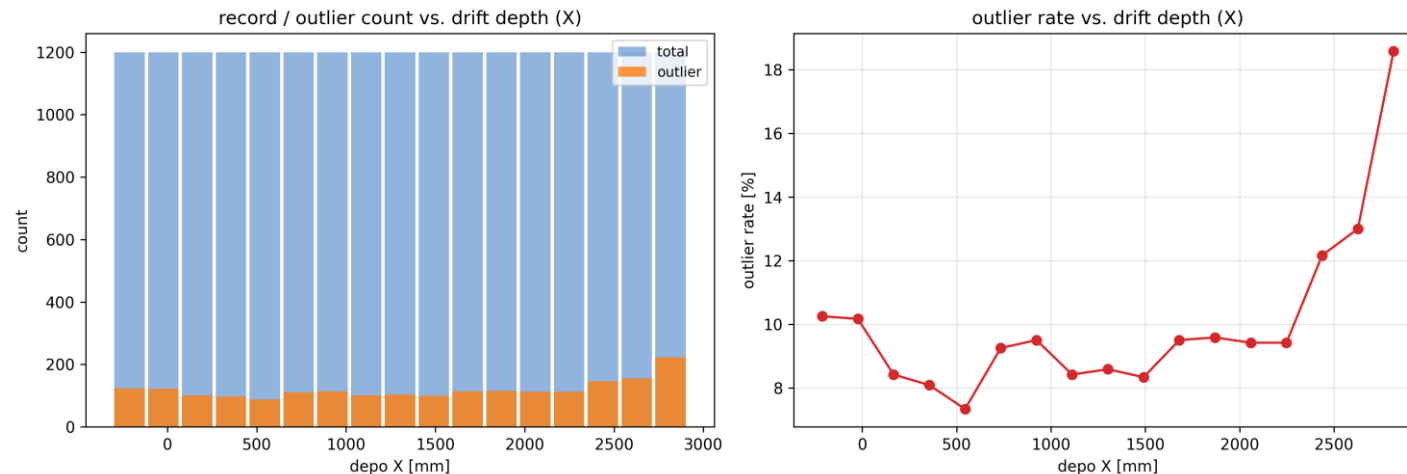
Depo-Blob Center Comparison

Does position dependence exist among outliers within the detector volume?

- The YZ plane was divided into a 10x5 bin grid to check the outlier ratio
-> No clear dependence observed yet



- A sharp increase is observed along the X-axis near the anode plane



Wire-Cell 3D Imaging

Depo-Blob Center Comparison

Conclusion

- For point depos, center mismatches are about 1mm.
- As observed in the outlier cases, blob size is expected to have a more significant impact than center mismatch on the position evaluation.

To Do

- Apply the same center comparison to simple tracks.
- Establish methods for evaluating blob size.
- DNNROI Paper

Backup

Wire-Cell 3D Imaging

Depo-Blob Center Comparison

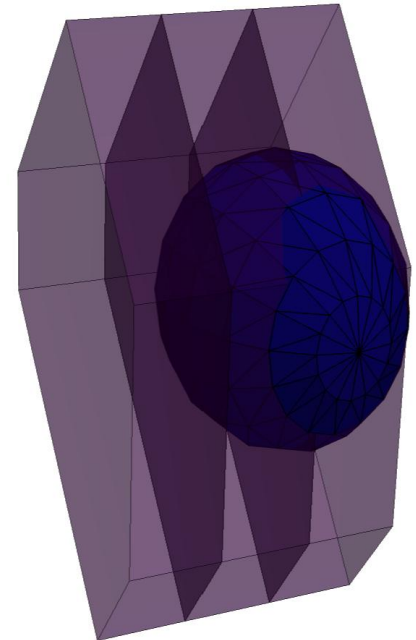
- Depo is a continuous object with longitudinal and transverse Gaussian distributions.
 - > Approximated as a 3D ellipsoid with boundaries at 3σ in longitudinal and transverse directions.

Depo Center Definition

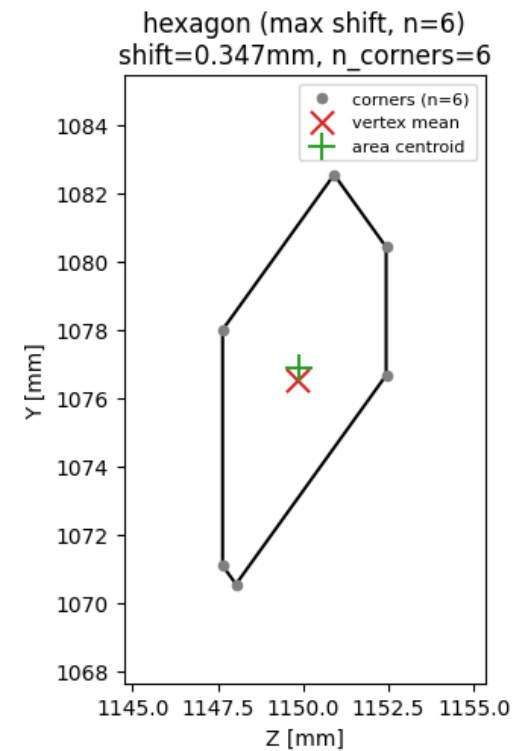
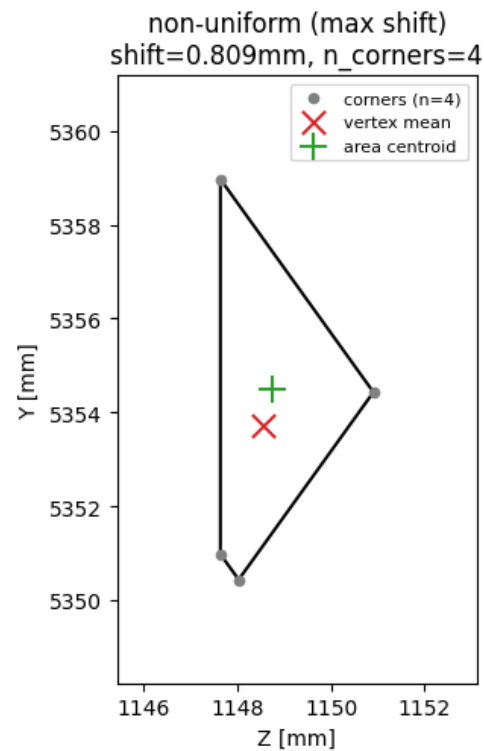
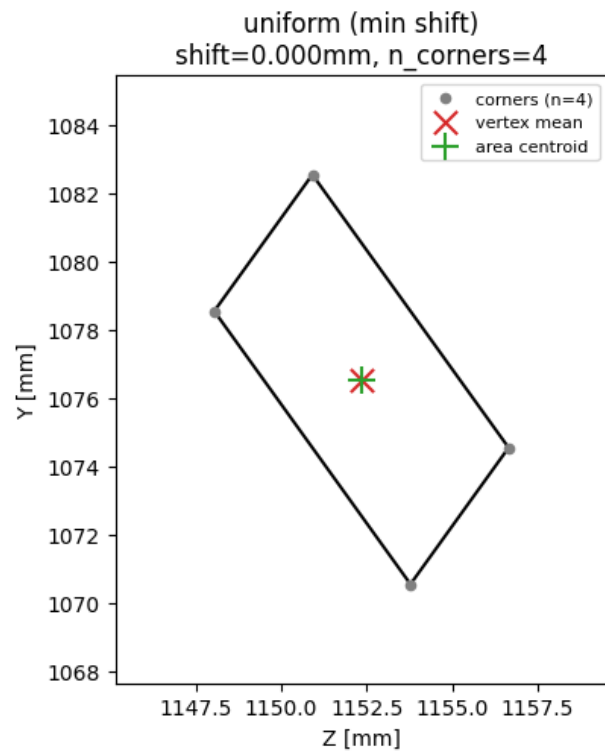
- Depo initial position $(t, x_{initial}, y, z)$ -> After drift $(t + \Delta t, x_{response\ plane}, y, z)$
- Since time offset (t_{offset}) b/w depo & blobs exists, depo initial position $(t, x_{initial}, y, z)$ couldn't be compared directly with blob centers.
- Instead, use $x = x_{response\ plane} - v_{drift} \cdot (\Delta t + t_{offset})$

Reconstructed Blob Center

- Depo spans more than one slice, 3 – 4 blobs are matched to one depo.
- To compare depo & blob center one-to-one,
 - Find center of each blob as an average of all corners.
 - Calculate charge weighted average center of 3 – 4 centers
 - This charge weighted center is one-to-one matched with the depo.



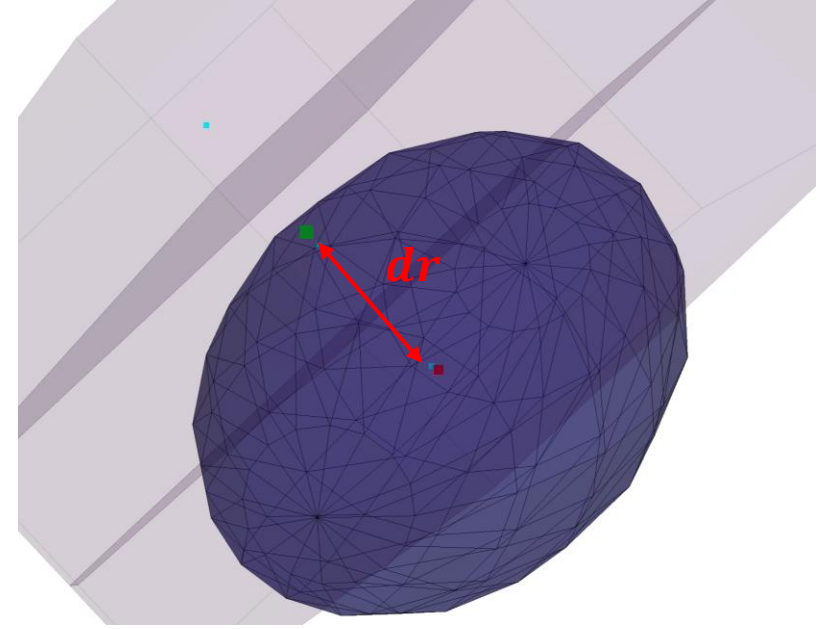
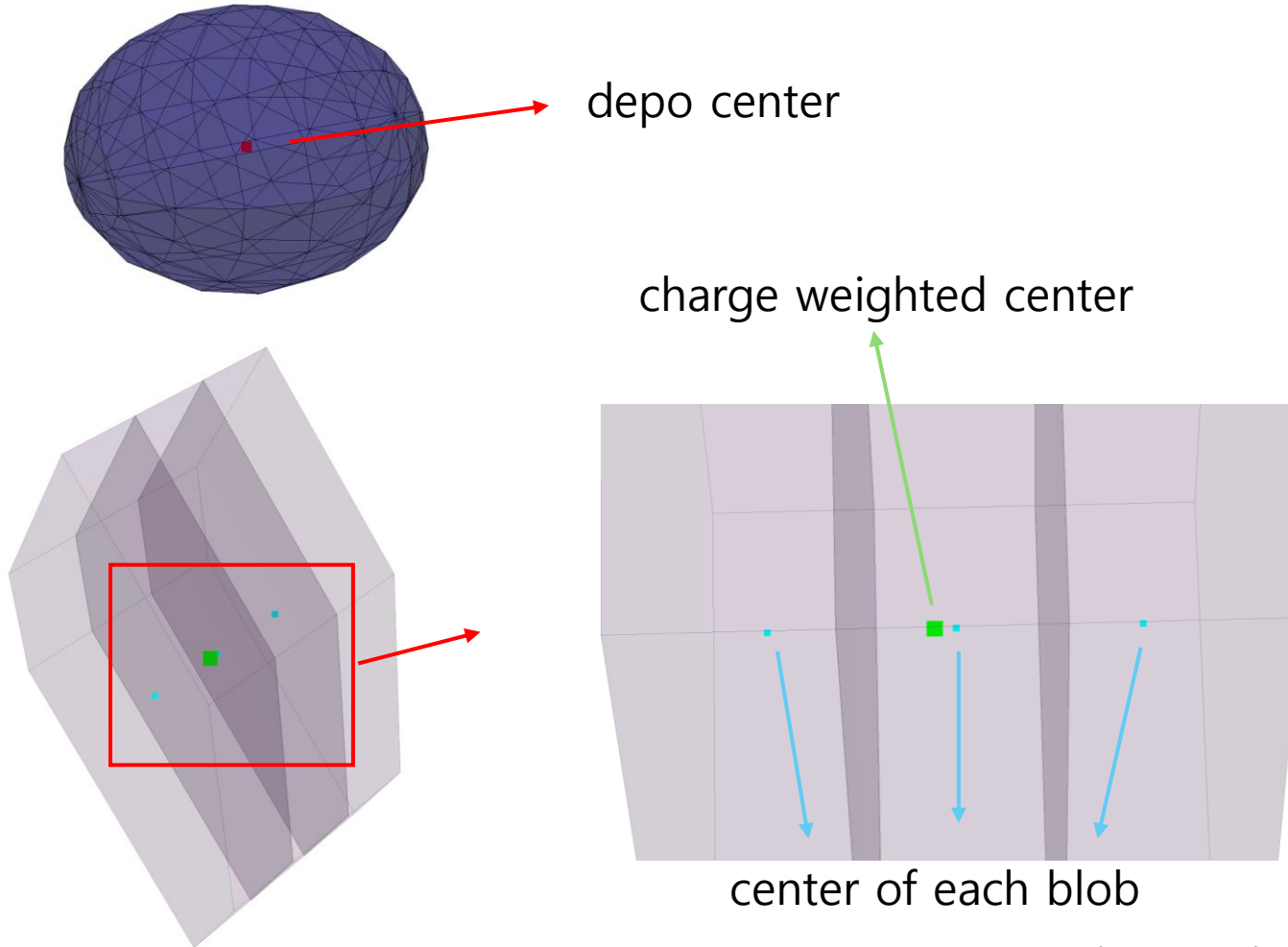
blob_center(): vertex mean vs. area centroid



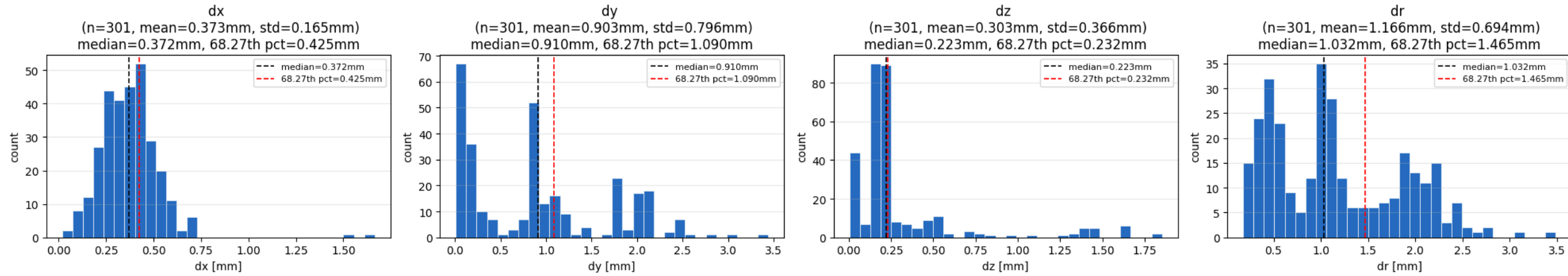
Wire-Cell 3D Imaging

Depo-Blob Center Comparison

Example

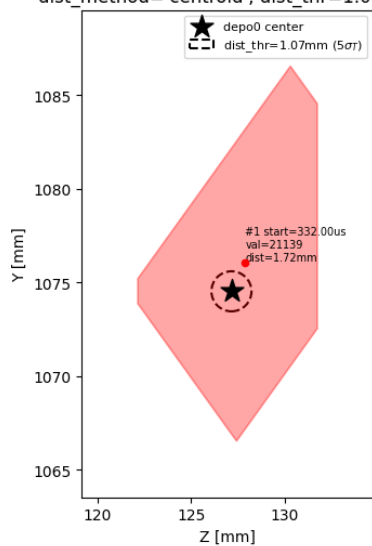


Depo center vs. charge-weighted blob center

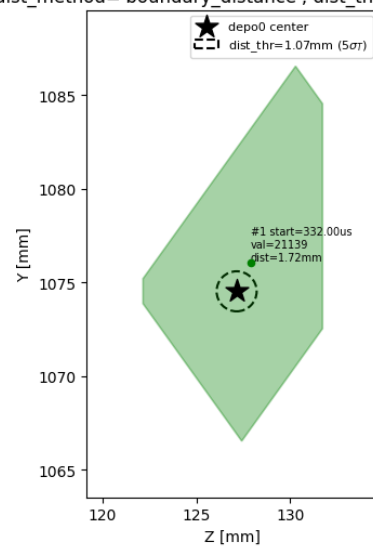


depo distance threshold (dashed circle) vs. blob center (green=matched, red=far_distance)

y107p453_z12p715, depo_idx=0 (near response plane, tiny sigma_T)
dist_method='centroid', dist_thr=1.07mm

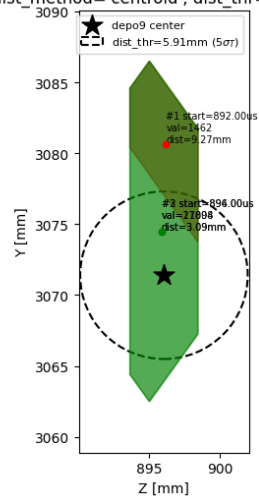


y107p453_z12p715, depo_idx=0 (same case, rescued)
dist_method='boundary_distance', dist_thr=1.07mm

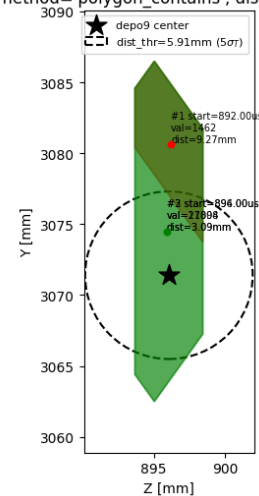


depo distance threshold (dashed circle) vs. blob center (green=matched, red=far_distance)

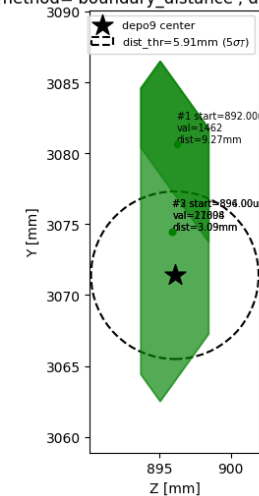
y307p140_z89p606, dist_method='centroid'
dist_method='centroid', dist_thr=5.91mm



y307p140_z89p606, dist_method='polygon_contains'
dist_method='polygon_contains', dist_thr=5.91mm

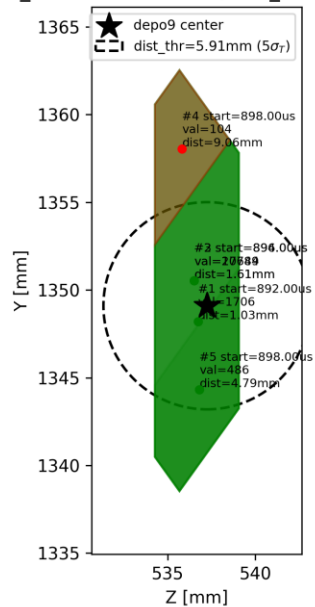


y307p140_z89p606, dist_method='boundary_distance'
dist_method='boundary_distance', dist_thr=5.91mm

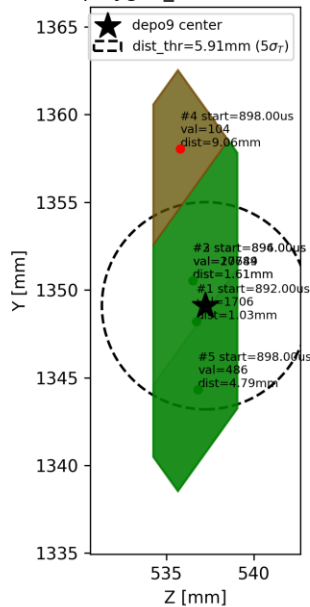


depo distance threshold (dashed circle) vs. blob center (green=matched, red=far_distance)

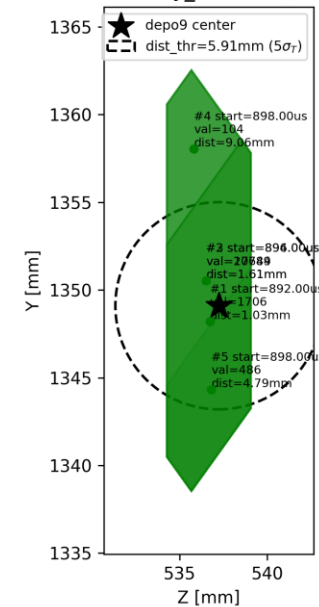
y134p910_z53p724, dist_method='centroid'
dist_method='centroid', dist_thr=5.91mm



y134p910_z53p724, dist_method='polygon_contains'
dist_method='polygon_contains', dist_thr=5.91mm

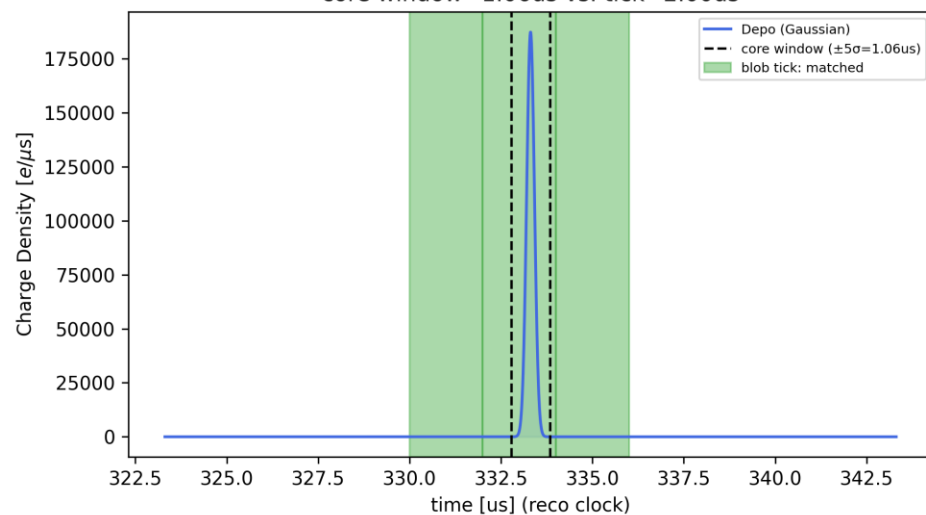


y134p910_z53p724, dist_method='boundary_distance'
dist_method='boundary_distance', dist_thr=5.91mm

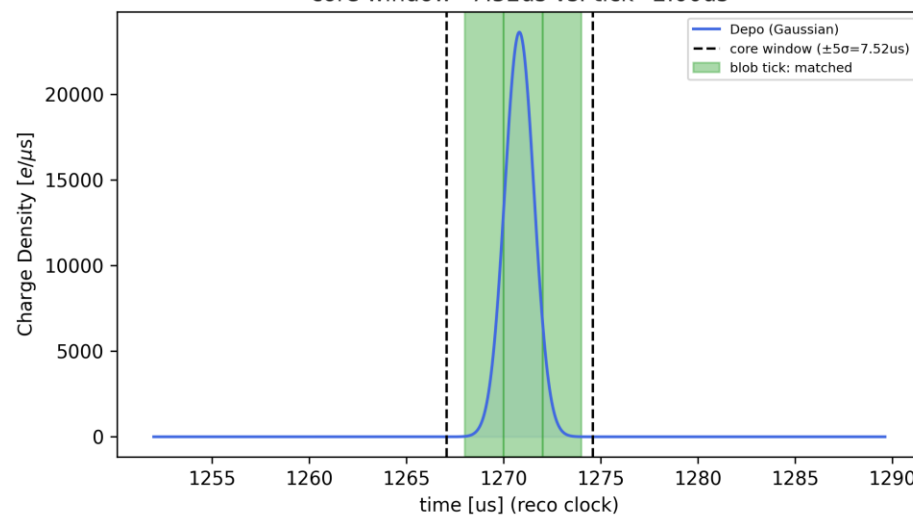


Actual match status (incl. tick-adjacency extension) vs. core window

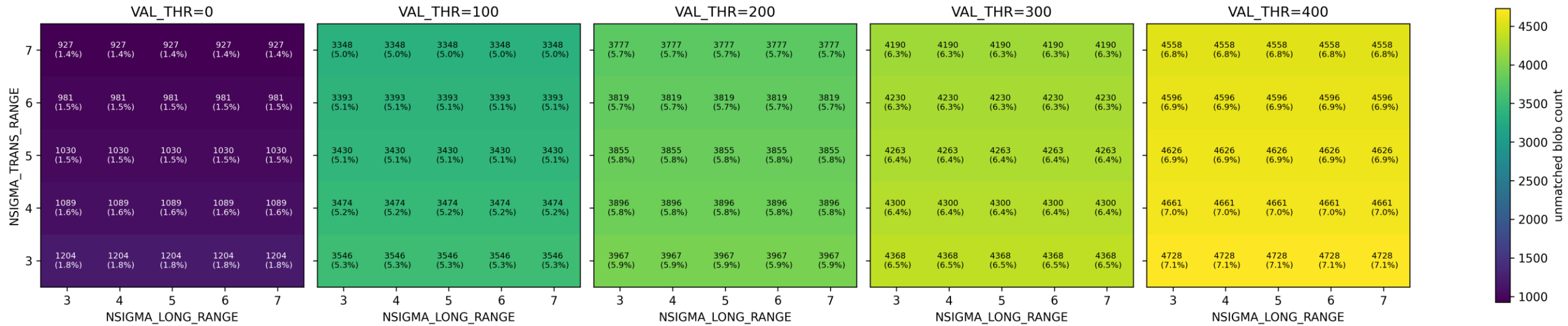
depo_idx=0 (near response plane, narrow window)
y134p910_z53p724 depo_idx=0
core window=1.06us vs. tick=2.00us



depo_idx=15 (mid-range, wide window)
y134p910_z53p724 depo_idx=15
core window=7.52us vs. tick=2.00us



Blobs never matched to any depo, by VAL_THR (total blobs=66766)



Study2: transverse dist_method comparison (VAL_THR=0, NSIGMA_LONG_RANGE=5)

