Anode-Anode Displacement Measurement

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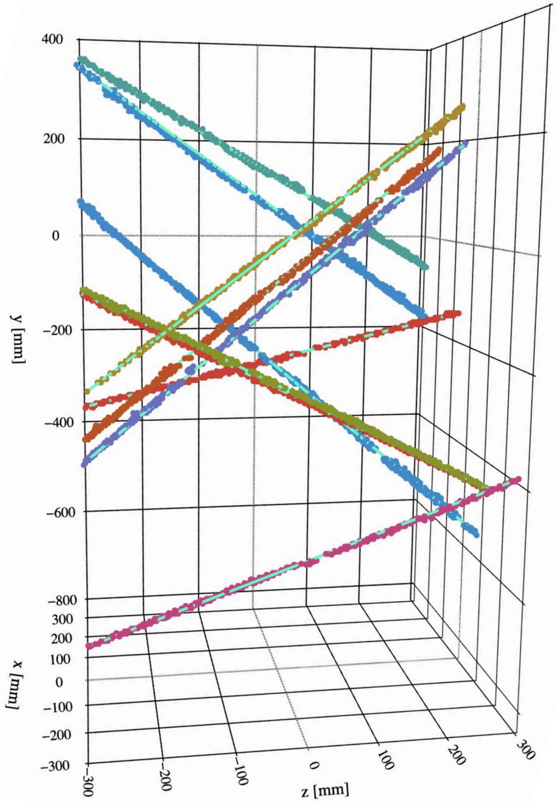
Anode-Crossing Curvature

We start with the assumption that displacement/deflection of drifting charges accumulates from anode to cathode.

Charges deposited close to the anode will undergo less drift, therefore have less time to be shifted

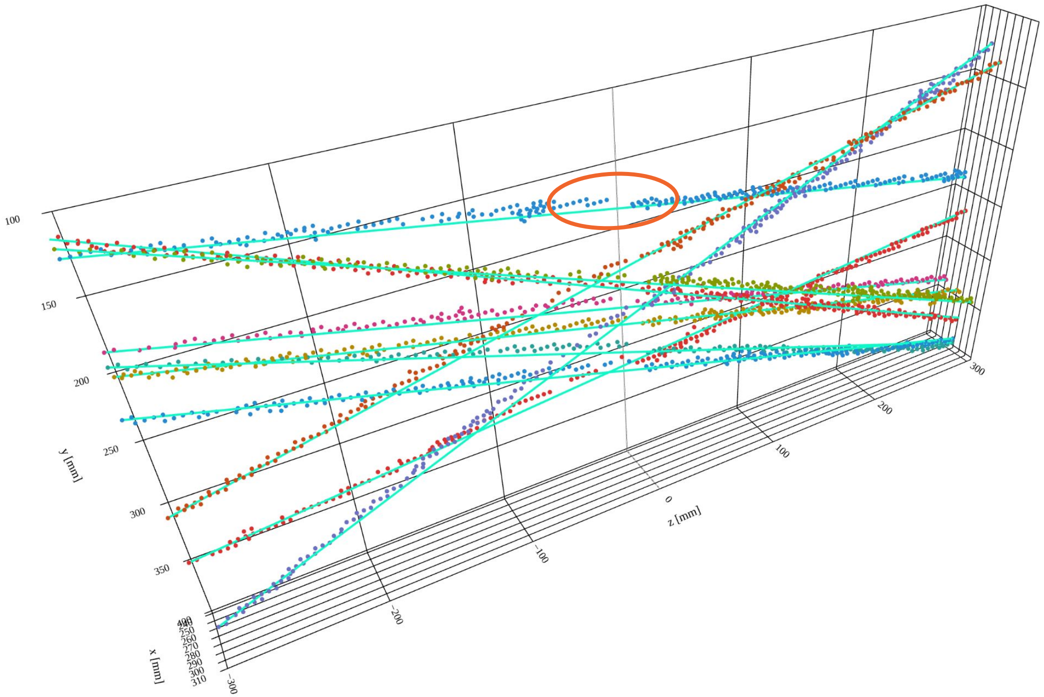
Using the first N hits near the anode, we can approximate the “true” track within the detector.

Since Module 0 and Module 1 are both double-TPC’s, we can use both anodes to anchor this true track hypothesis, giving tracks that are not affected by distortion near the cathode.

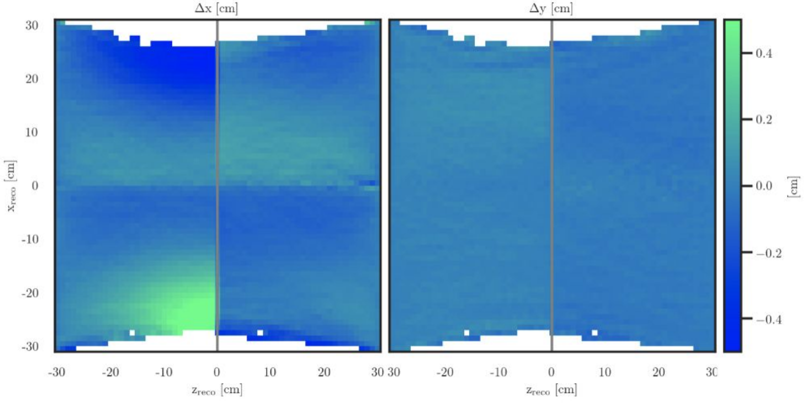


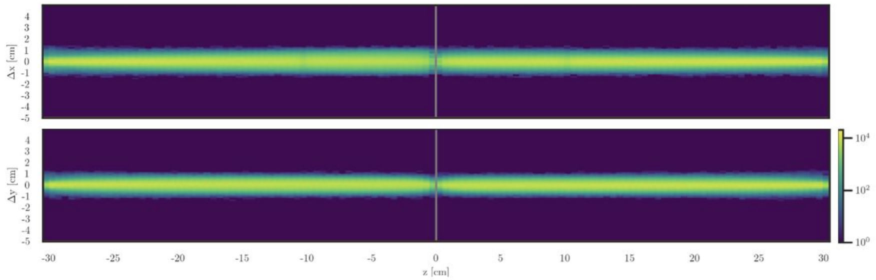
Hit-to-Axis Displacement

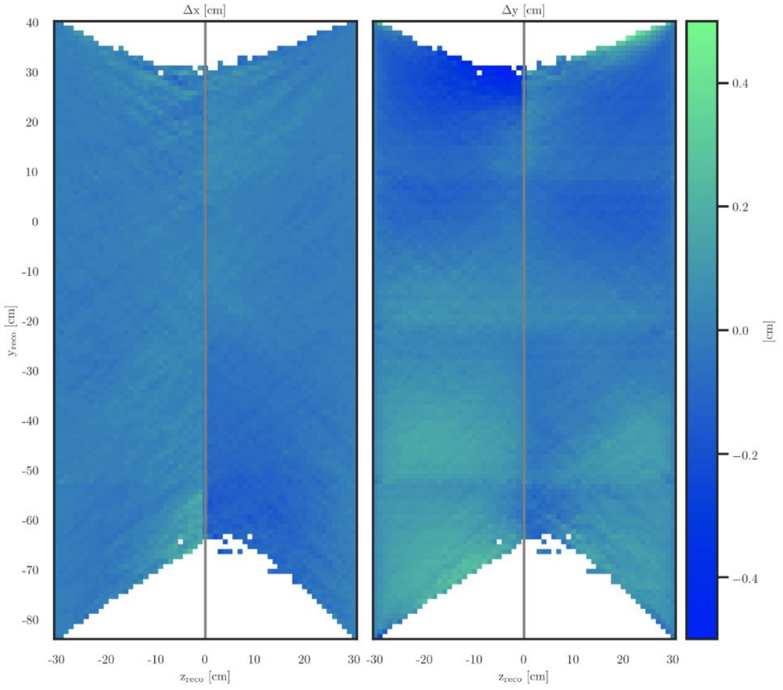
Using the two anode anchors, we can compare the hit locations ("reco" position) to the true charge locations ("true" position). The difference between these two is more prominent as the drift time gets longer (near the cathode)



2D Displacement Projections (Anode-Anode)



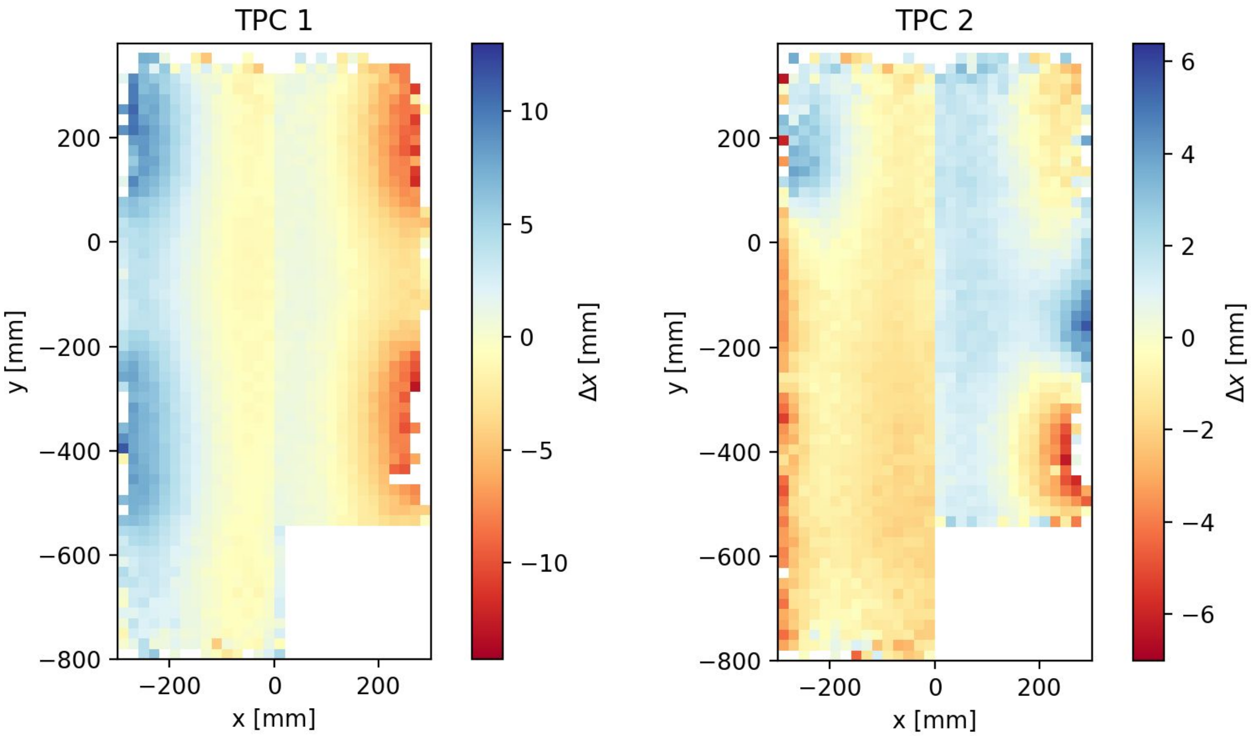




Cathode-Facing Hit Displacement

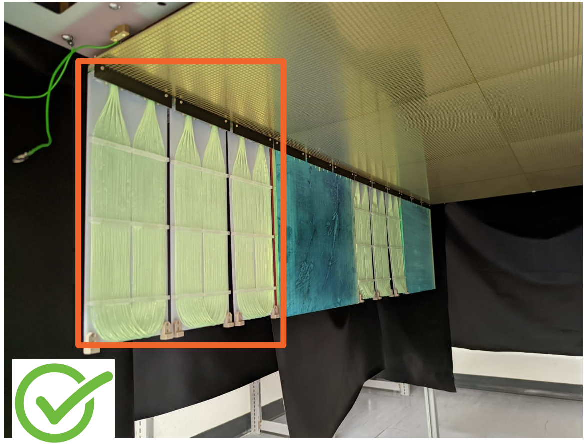
By looking at just the hits closest to the cathode (on each side) for anode-anode tracks, we can get a slice view of the cathode displacement

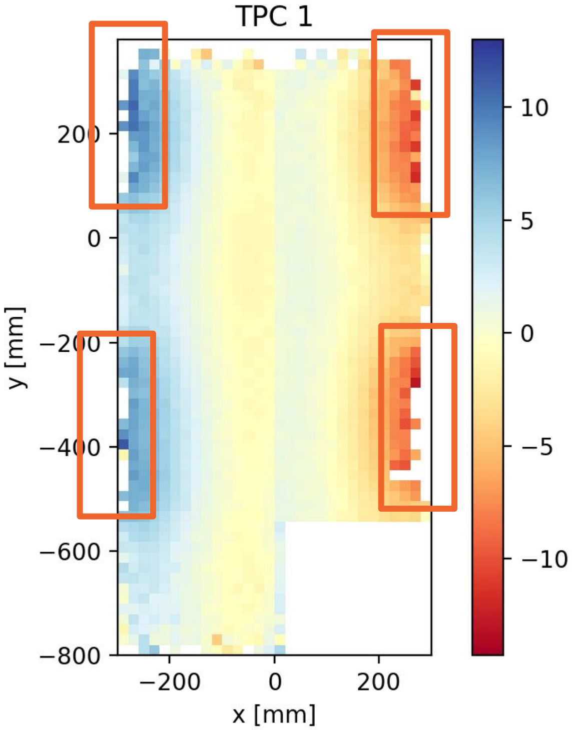
x displacement is shown here

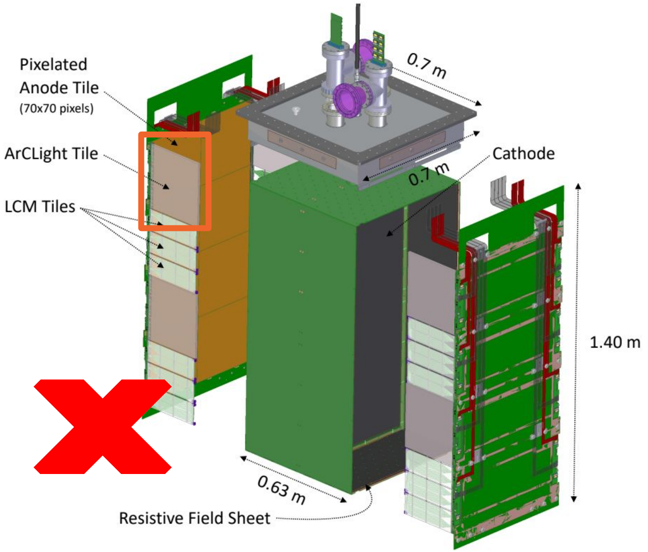


Cathode-Facing Hit Displacement

Regions of unusually high x-displacement seem to correlate with the location of LCM tiles, but not ArCLight Tiles!







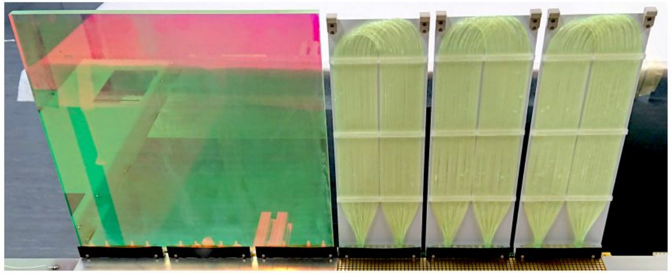


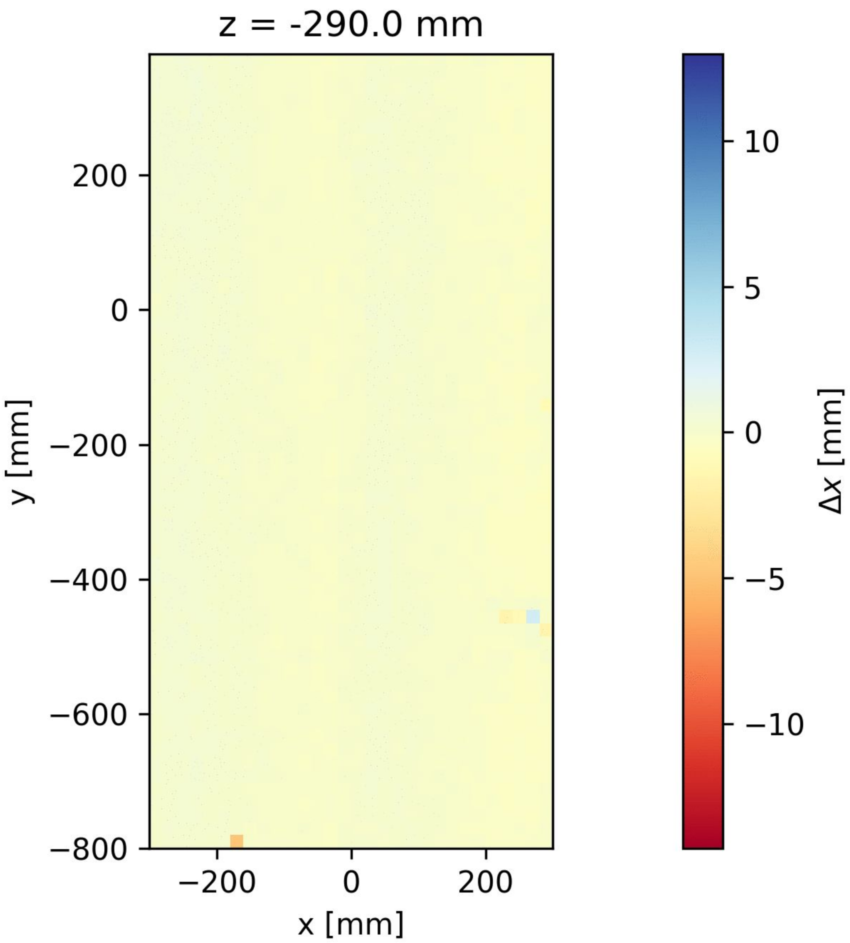
Figure 7. An ArCLight tile (left) and three LCM tiles (right).

Volumetric Scans

Can plot these quantities in any projection, scanning different axes

Some extras included in backups

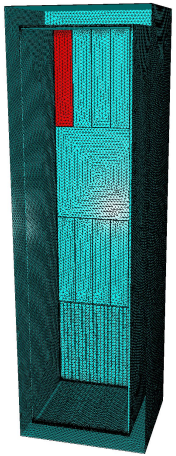
More upon request!

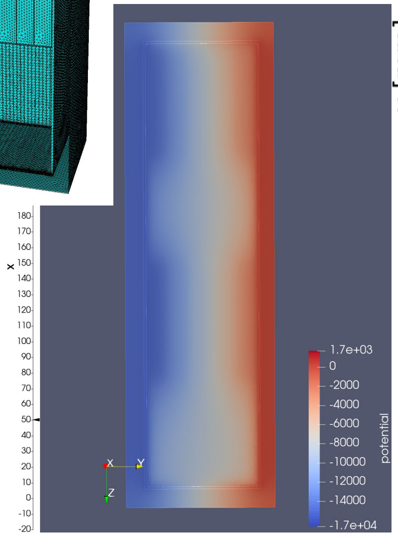


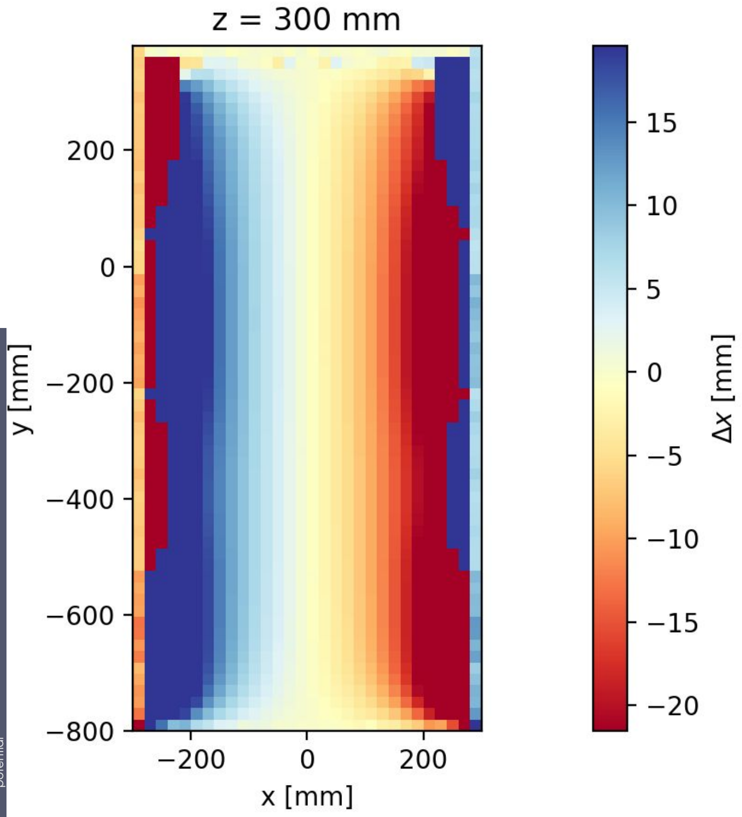
FEM Simulation of LCM Bias

Adapting Ellie's FEM workflow to add a biased gradient to the LCM panels, voltage should be closer to the cathode HV so that electrons are deflected inwards.

Work in progress!

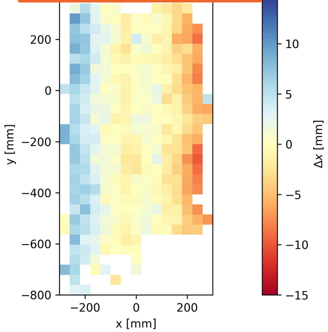




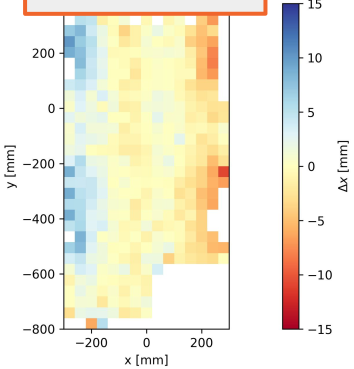


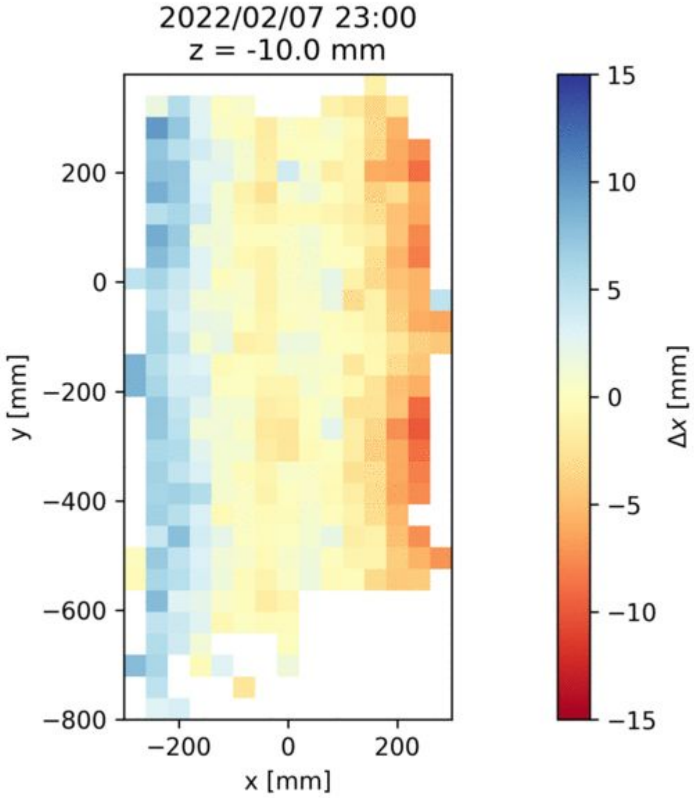
Time Evolution of x Displacement

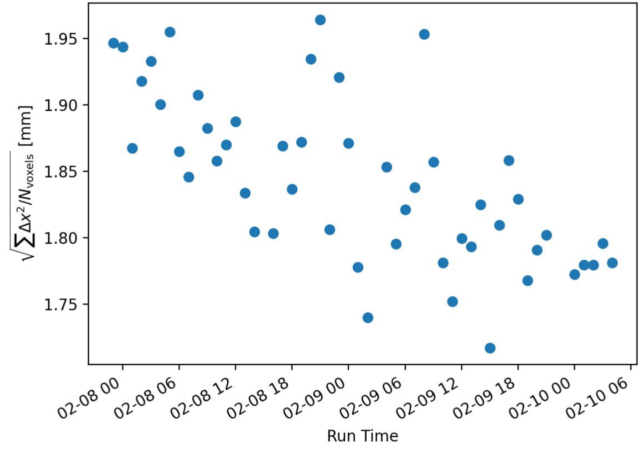
First sub-run



Last sub-run



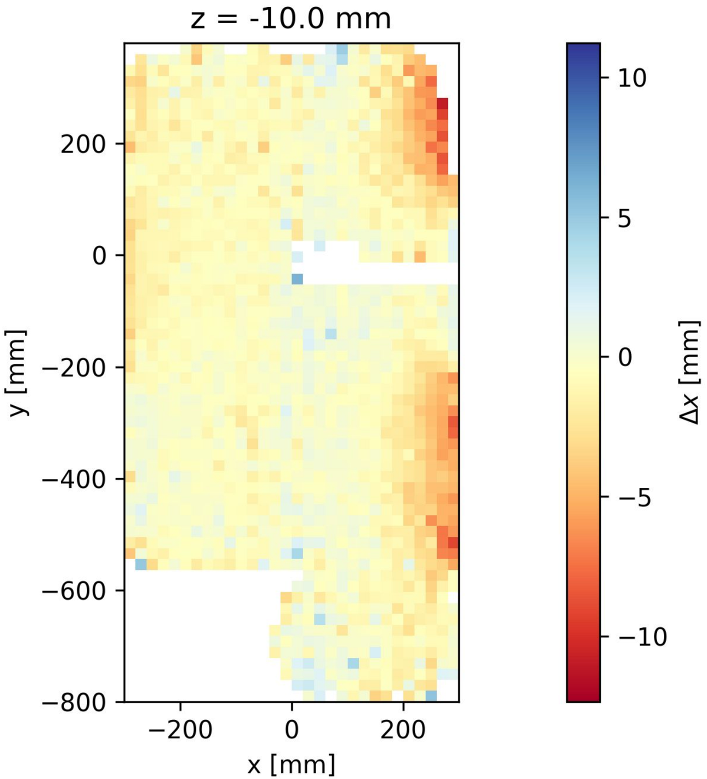


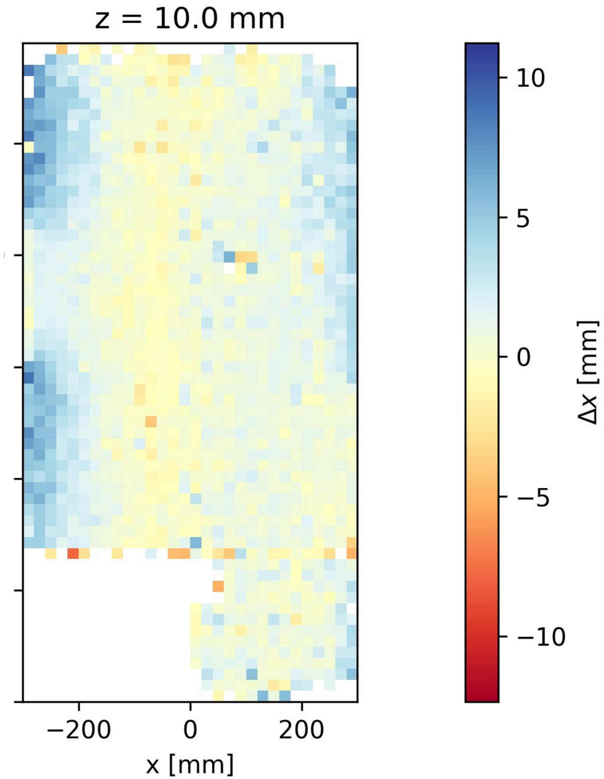


Variance of Δx over the run shows a small negative correlation with time?

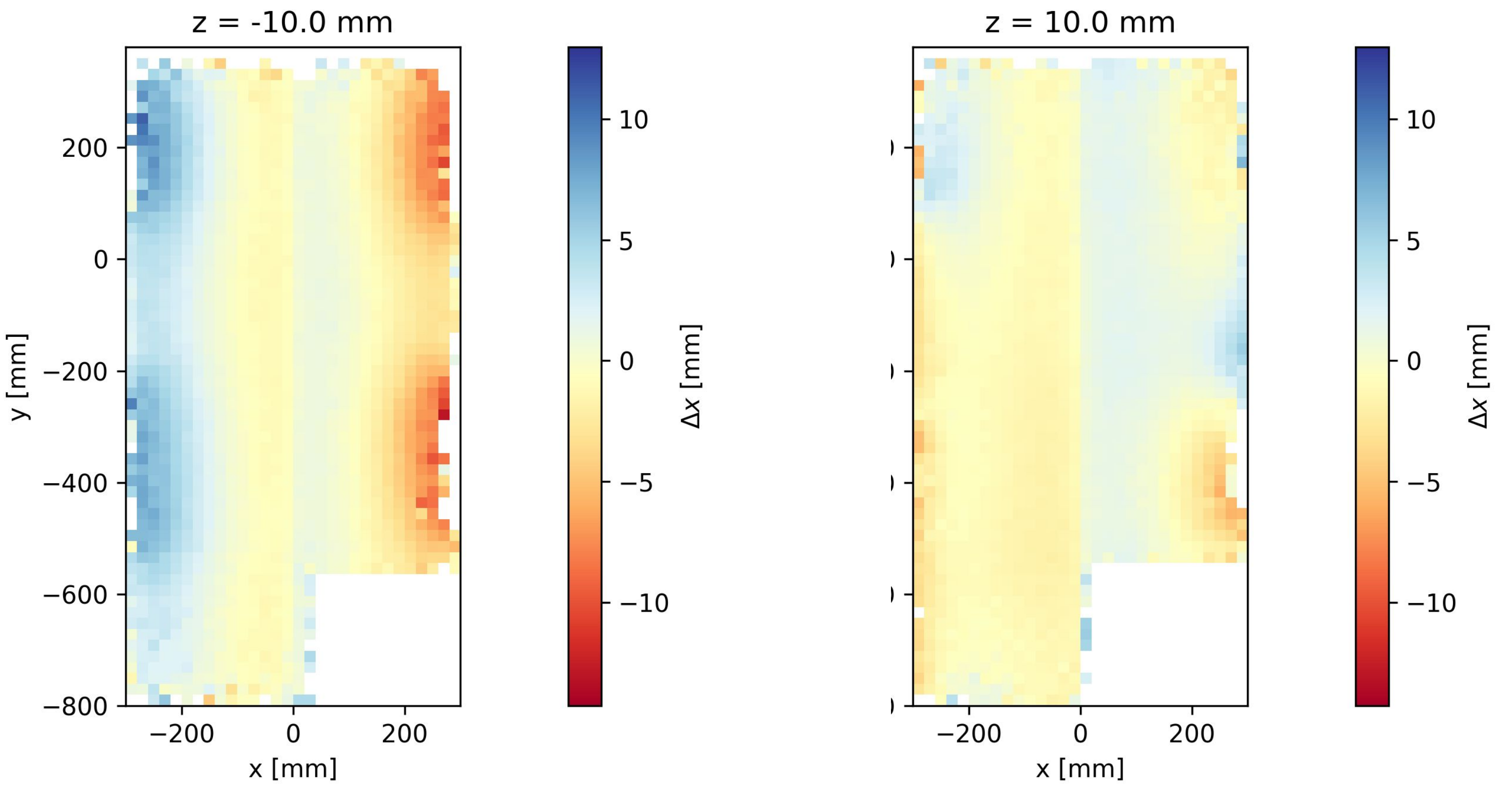
Not consistent with charge accumulation *during this run*

Module0 x Displacement





Module1 x Displacement



Next Steps

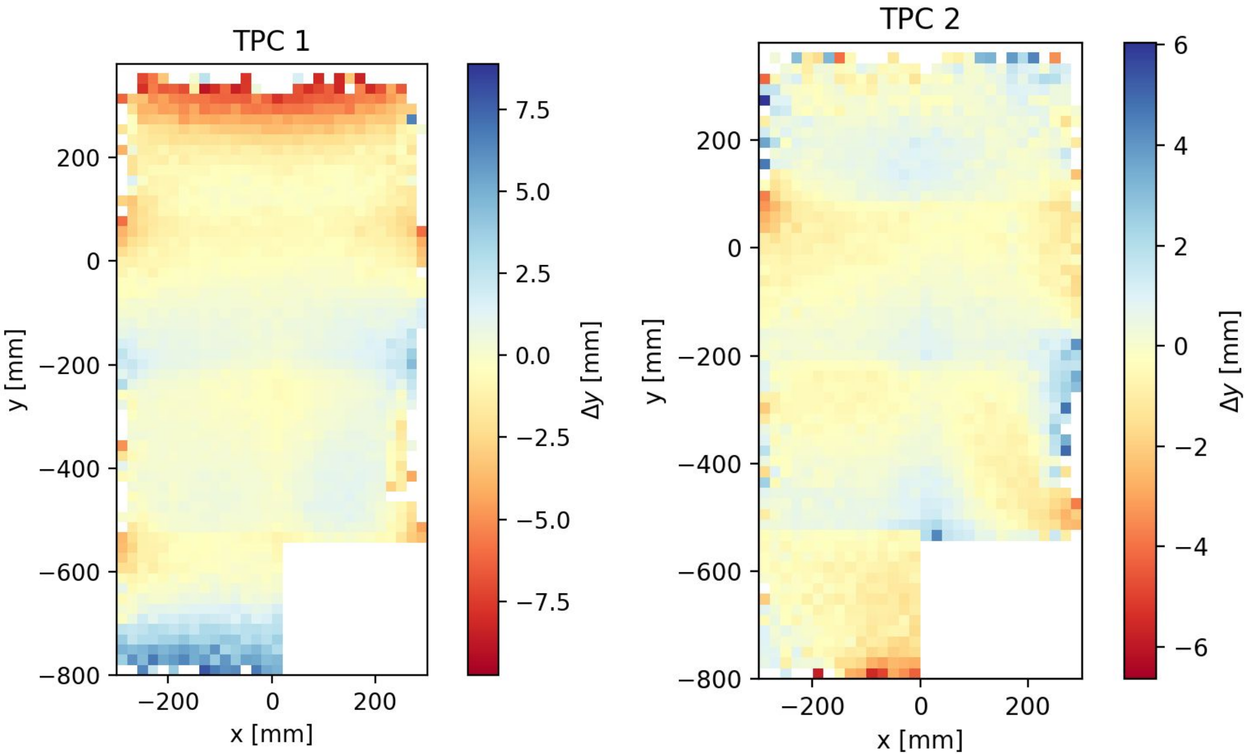
- Tune the axial/radial uncertainty values
- Compare with single-anode measurement (towards a SLACcube measurement)
- Try to run FEM simulation with appropriate charge/voltage bias to try to
- Examine runs individually to try to identify time evolution

BACKUP

Cathode-Facing Hit Displacement (y-Direction)

By looking at just the hits closest to the cathode (on each side) for anode-anode tracks, we can get a slice view of the cathode displacement

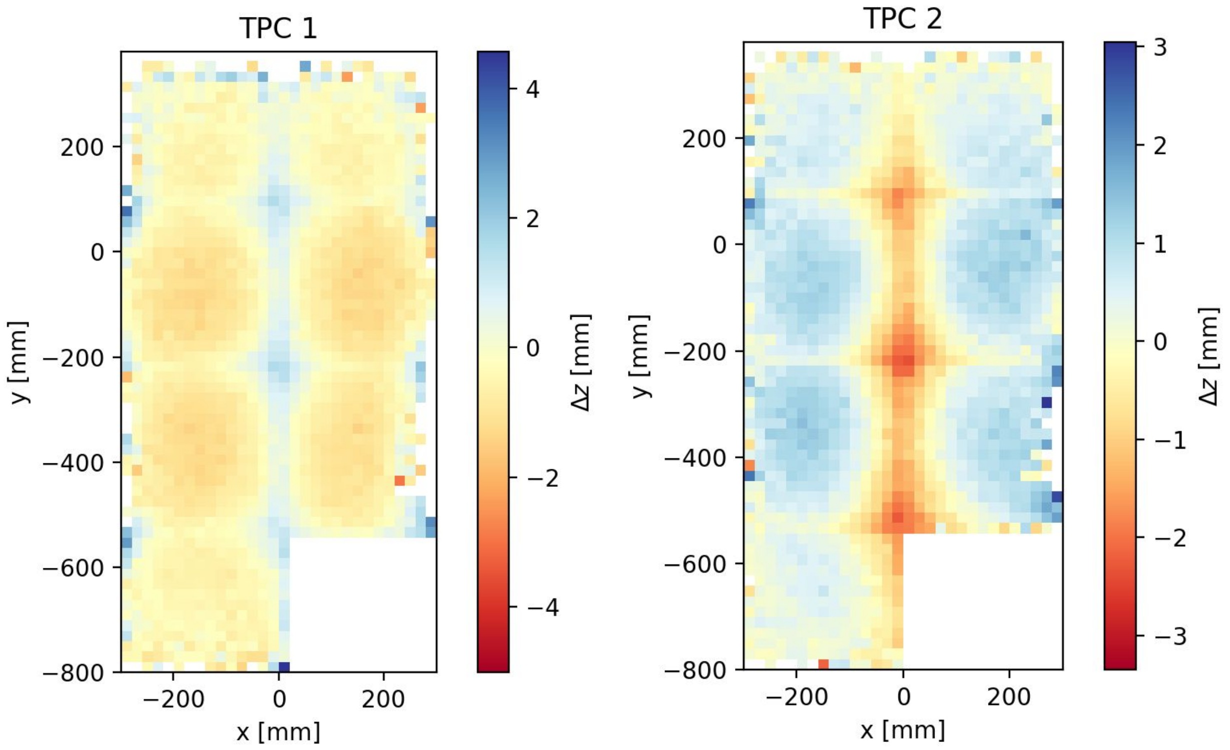
Y displacement is shown here



Cathode-Facing Hit Displacement (*z*-Direction)

By looking at just the hits closest to the cathode (on each side) for anode-anode tracks, we can get a slice view of the cathode displacement

Z displacement is shown here



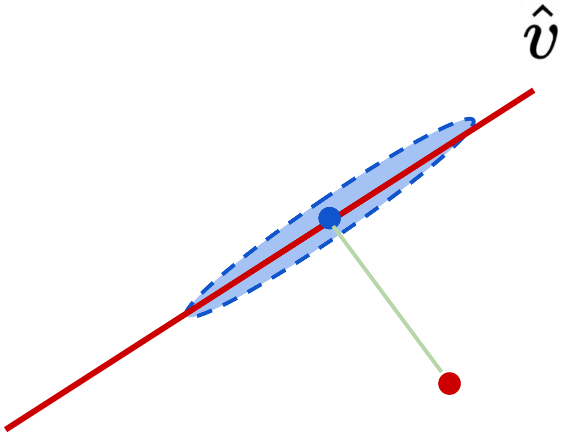
True Hit Location and Uncertainty

Now assuming "true" hit location is the nearest point on the "true" track axis

Really, there's some range of positions along the axis

Instead of assuming a point, assume a gaussian cloud ("football" shaped, smeared along the track direction)

Weight the contribution to the overall displacement map according to the uncertainty

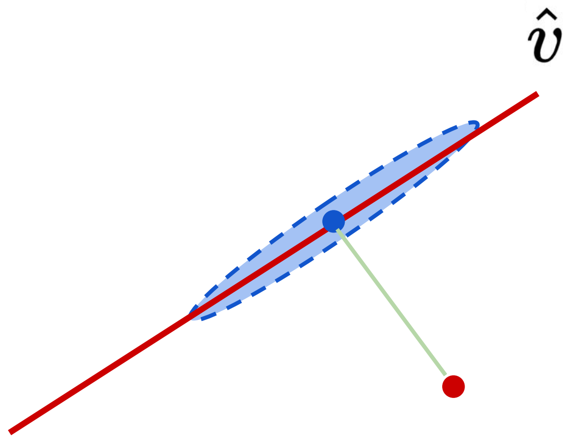


True Hit Location and Uncertainty

Define a metric for confidence in the axial and radial directions

This is a relative weighting for now (only the ratio of the two effects the end product)

The widths, σ_{axial} and σ_{radial} are left as parameters for now, though they can reflect expected track width from ionization/recombination/diffusion.



For an *x* projection,

$$\sigma_x = \sqrt{\left((\hat{v} \cdot \hat{x})\sigma_{\text{axial}}\right)^2 + \left(|\hat{v} \times \hat{x}|\sigma_{\text{radial}}\right)^2}$$

True Hit Location and Uncertainty

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TO DO: add uncertainty owing to PCA axis (necessary to adapt to a single-sided TPC!)

Th

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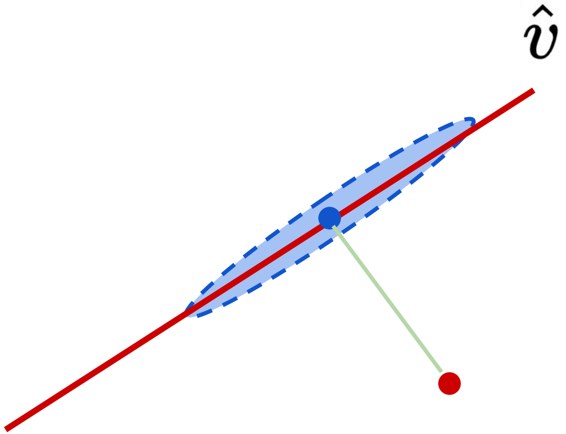

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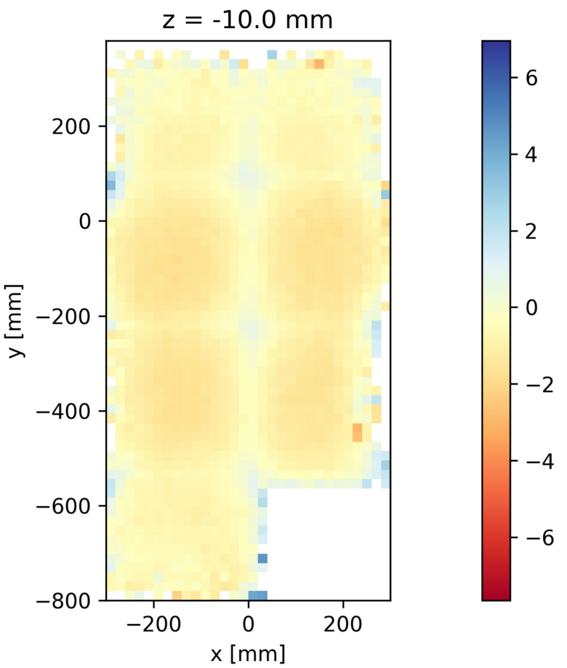
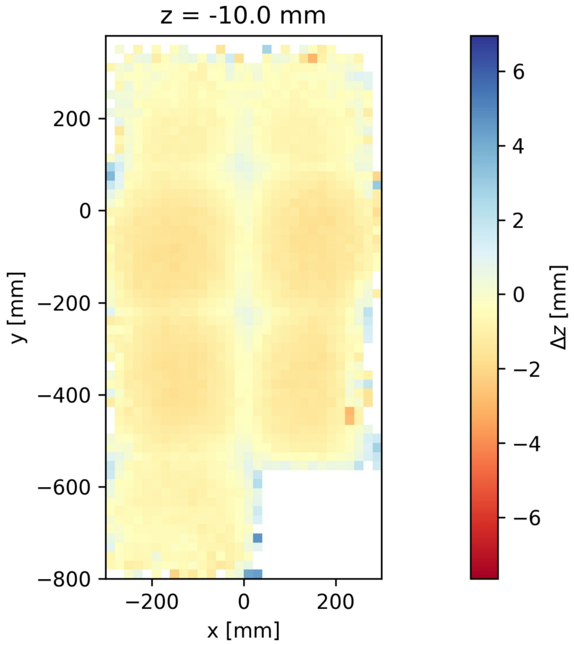
Sanity Checks: *z*-displacement

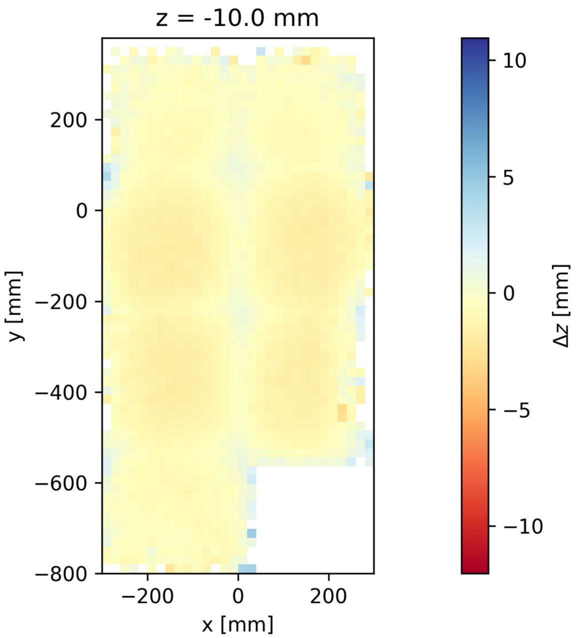
Z displacement is most heavily influenced by axial displacements



no weighting

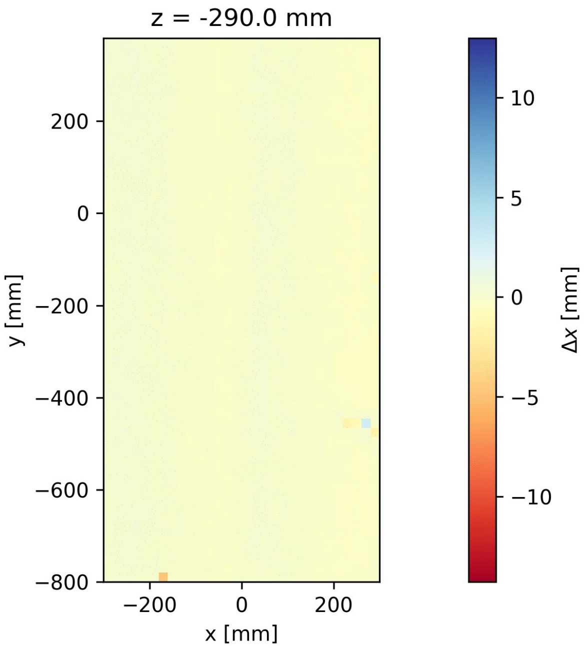


equal weighting

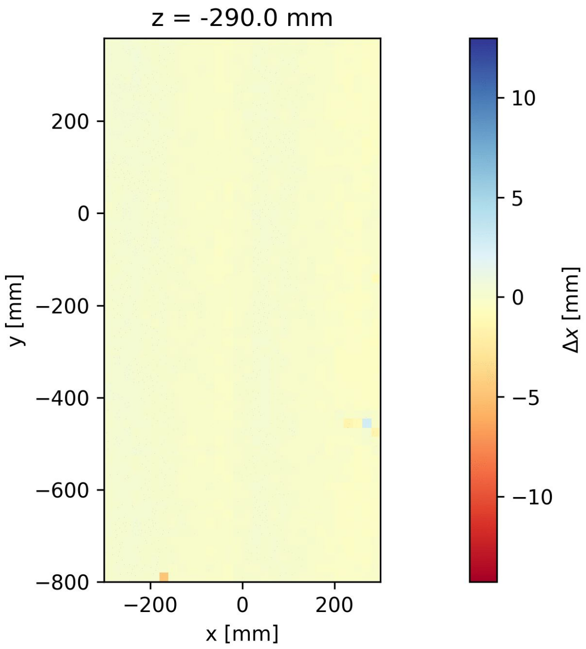


axial weighting: 10^{20}

Volumetric Scans with Weighting



no weighting



axial weighting = 10^3