

Inter-Plane Induction Effects (and more...)

Tom Junk, Ajib Paudel, Tingjun Yang

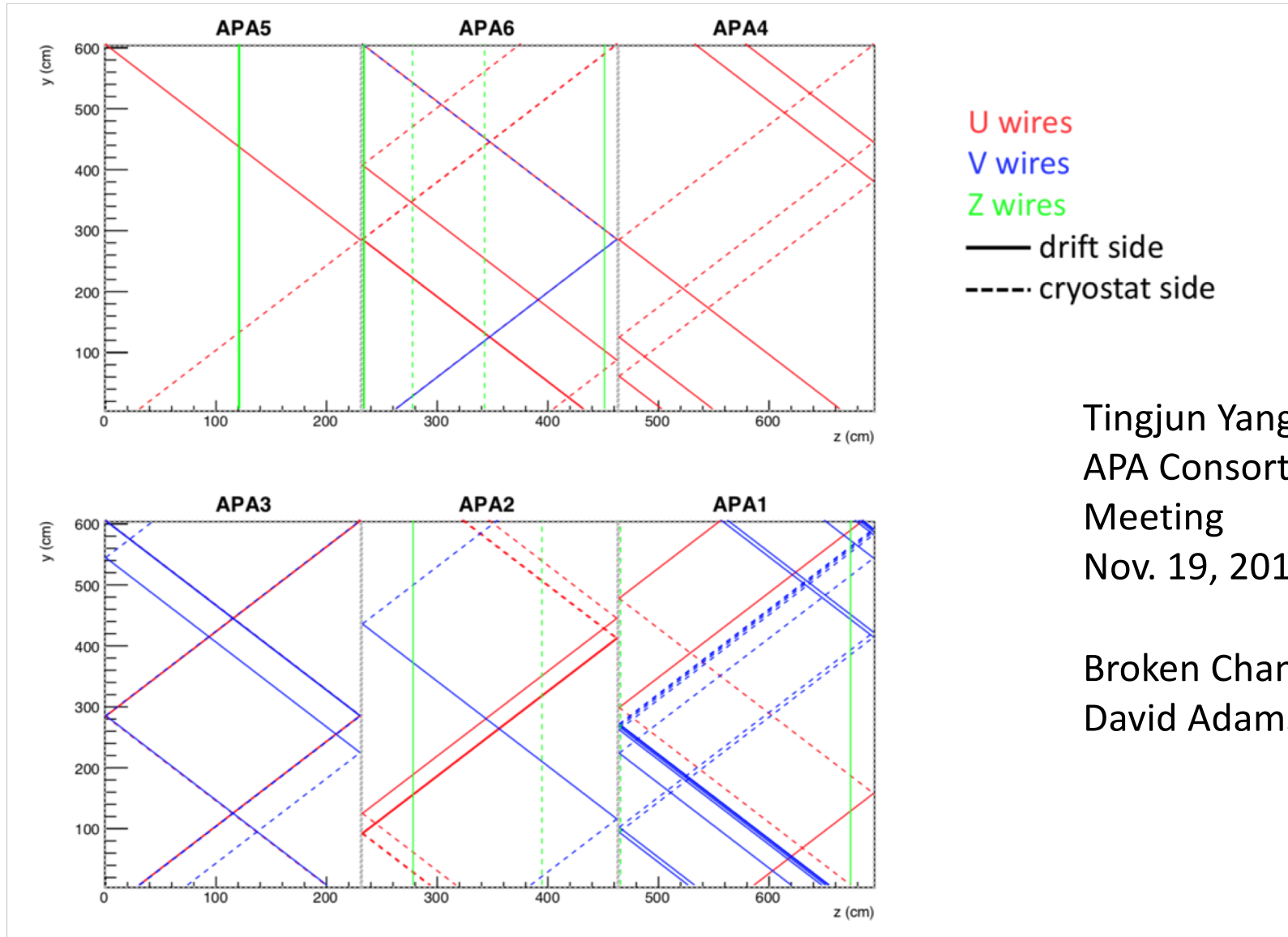
ProtoDUNE Sim/Reco Meeting

December 12, 2018

Ajib did all the heavy lifting.



Broken Channels in ProtoDUNE-SP



Tingjun Yang,
APA Consortium
Meeting
Nov. 19, 2018

Broken Channel List from
David Adams

Alberto's Request

- Can we see the effect of the broken collection wires in the V plane?
- We expect the potential map to be distorted if the collection-plane wire is floating
- Less so if the collection-plane wire is jumpered to its neighbor
- If a U or a V wire is broken and floating, expect less of an impact. Charge should not collect on a disconnected wire, or on a connected one.
- MicroBooNE had a significant effect on neighboring plane wires due to shorted wires. We have far fewer broken wires and they are isolated. Can we see the impact?

The (Proto)DUNE-SP Anode Potential Map

From The LBNE CDR, Vol. 4

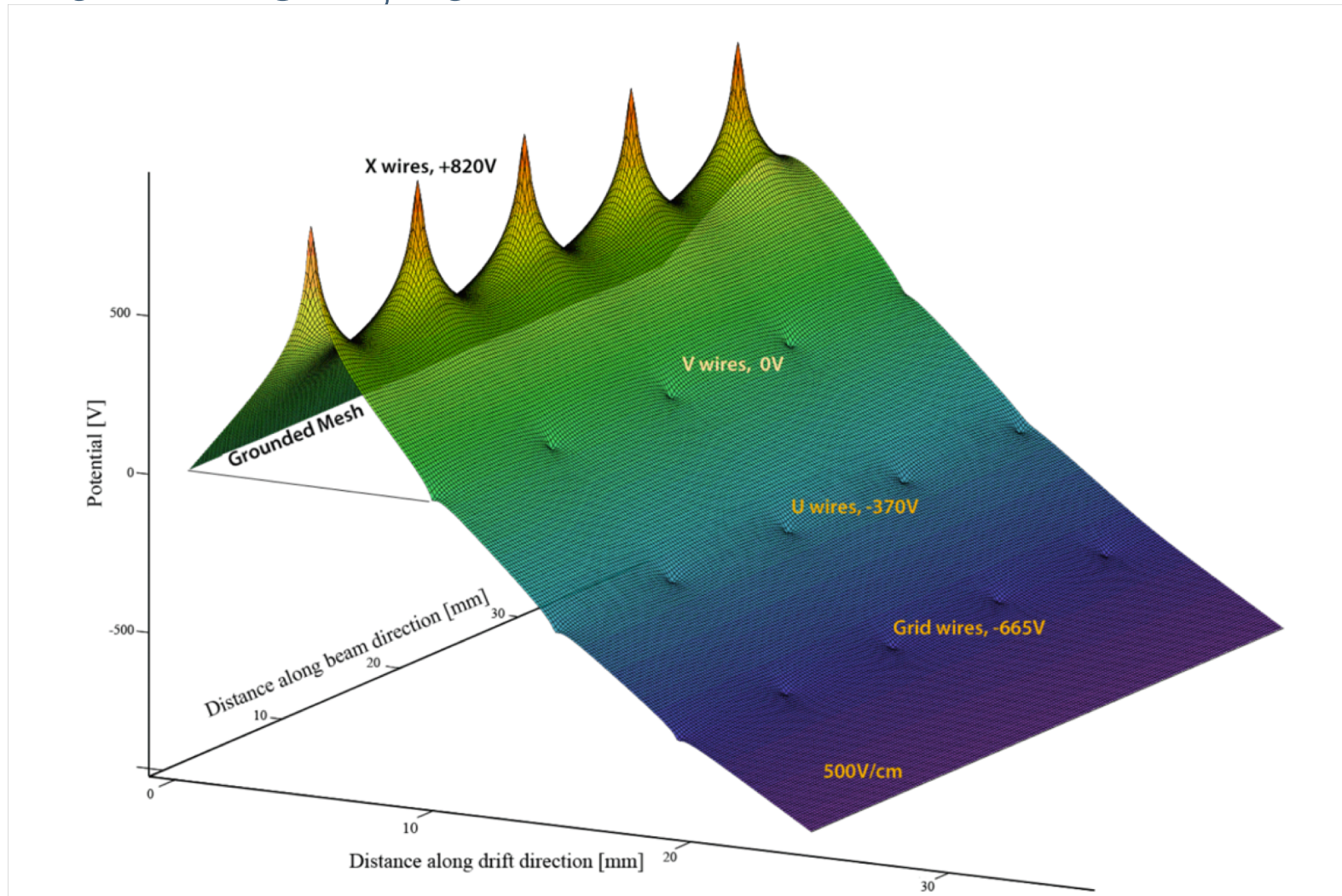
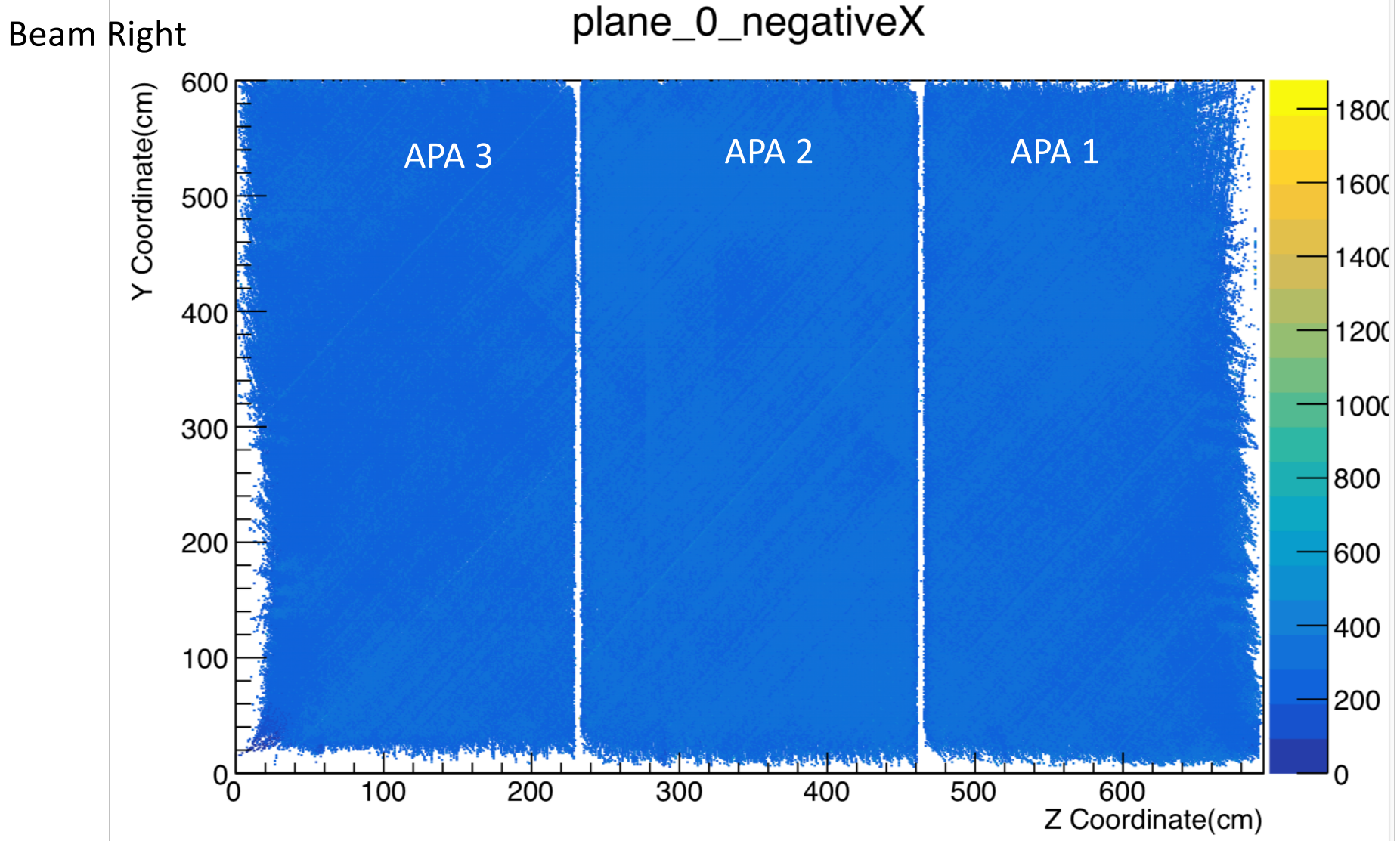


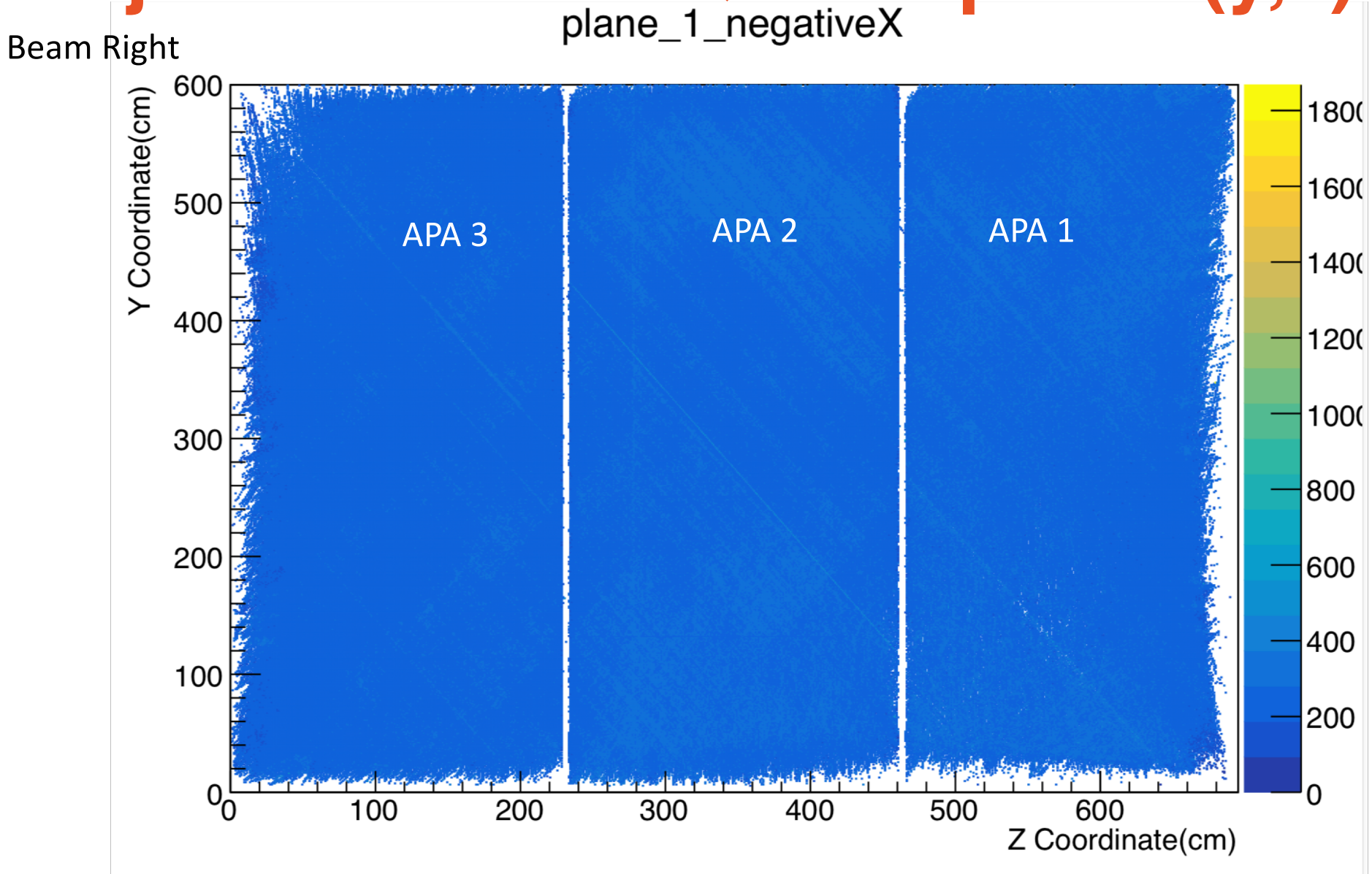
Figure 3–3: A surface plot of the electric potential distribution near the wire planes. The voltages on the wire planes are biased to provide complete electron transparency through the first three planes, and complete collection on the fourth plane.

Ajib's Median dQ/dx U plane (y,z)



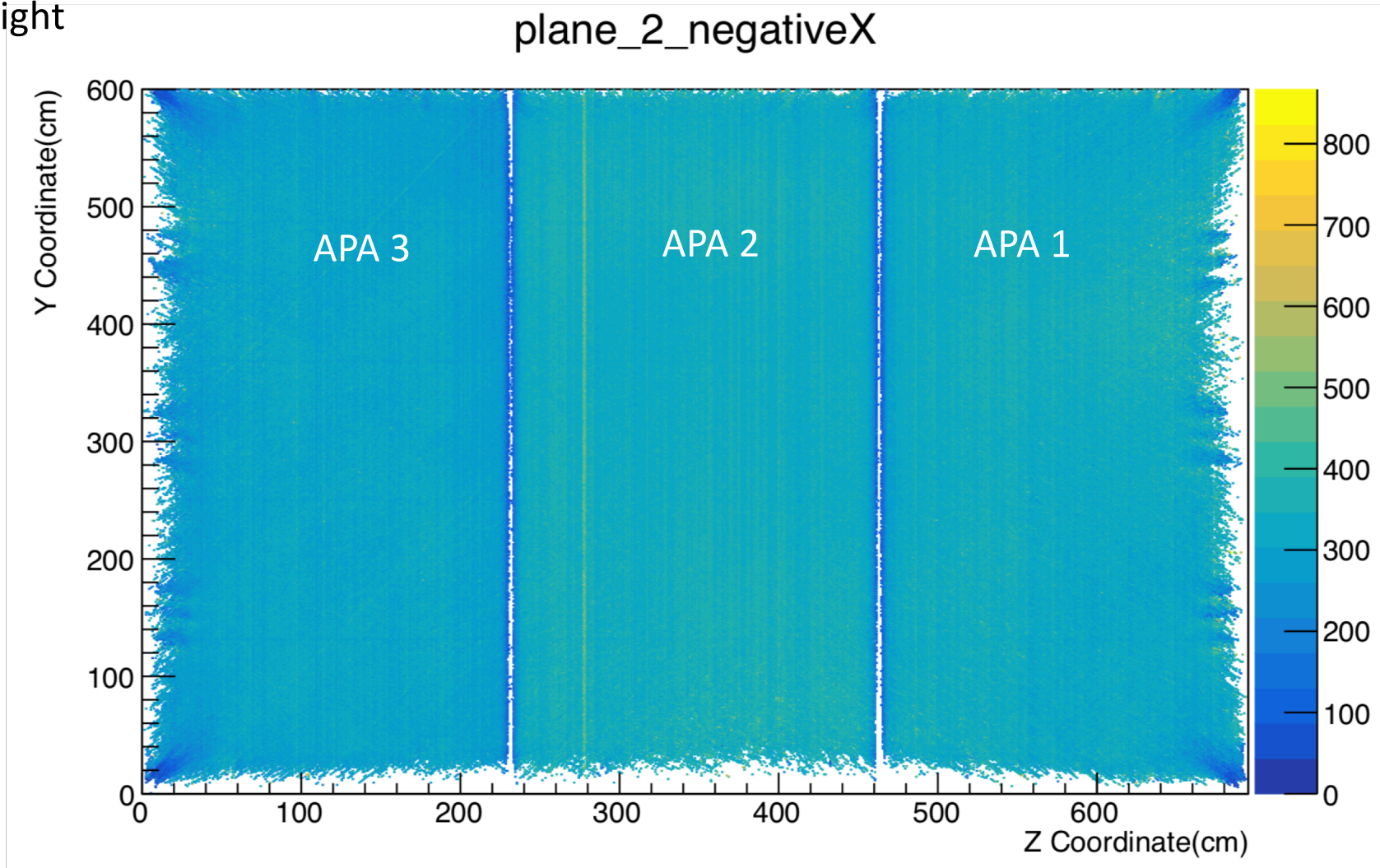
86000 Events, 1 cm x 1 cm binning

Ajib's Median dQ/dx V plane (y,z)



Ajib's Median dQ/dx Z plane (y,z)

Beam Right

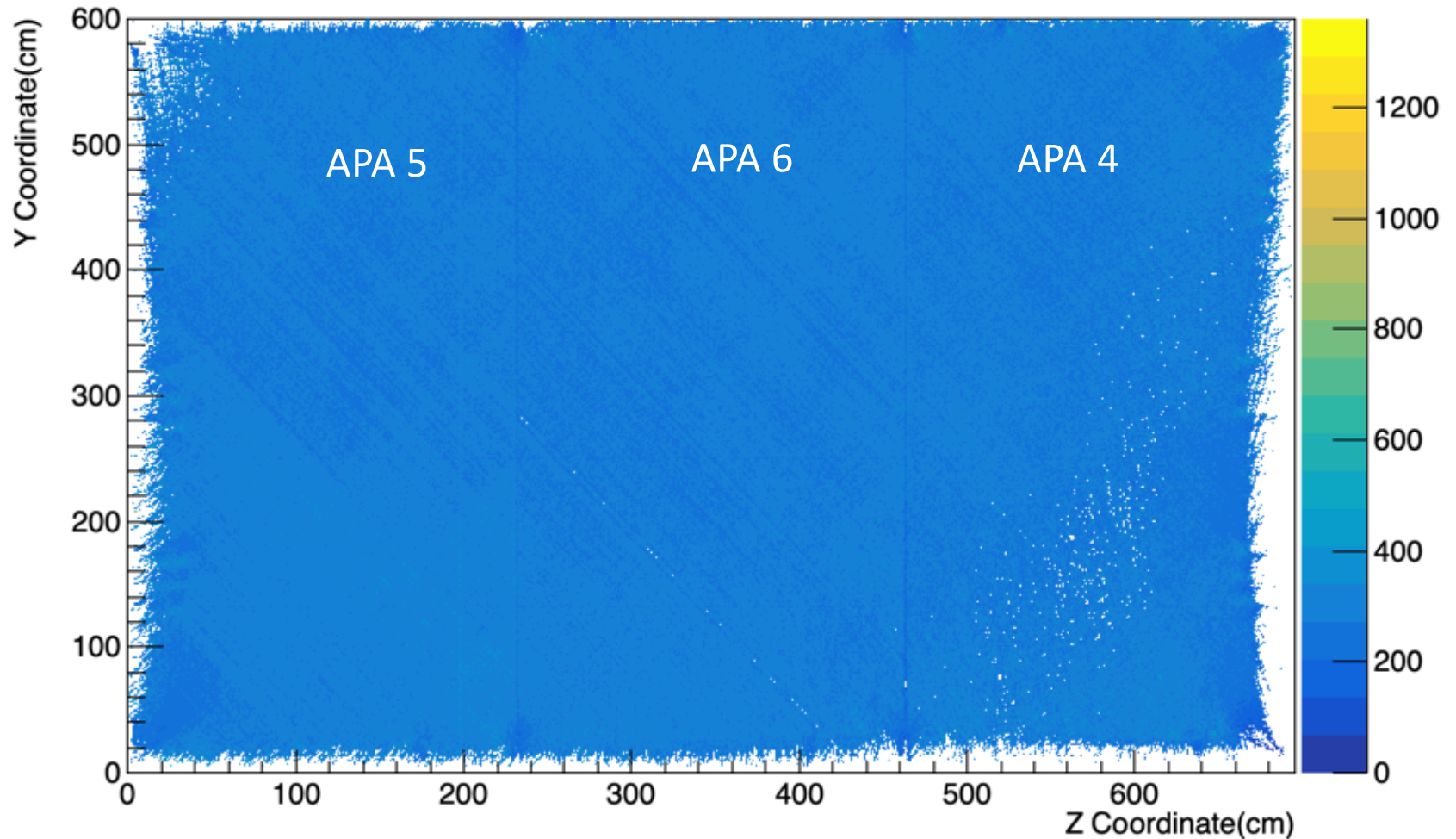


And similarly for APA's 4, 6, and 5

Ajib's Median dQ/dx U plane (y,z)

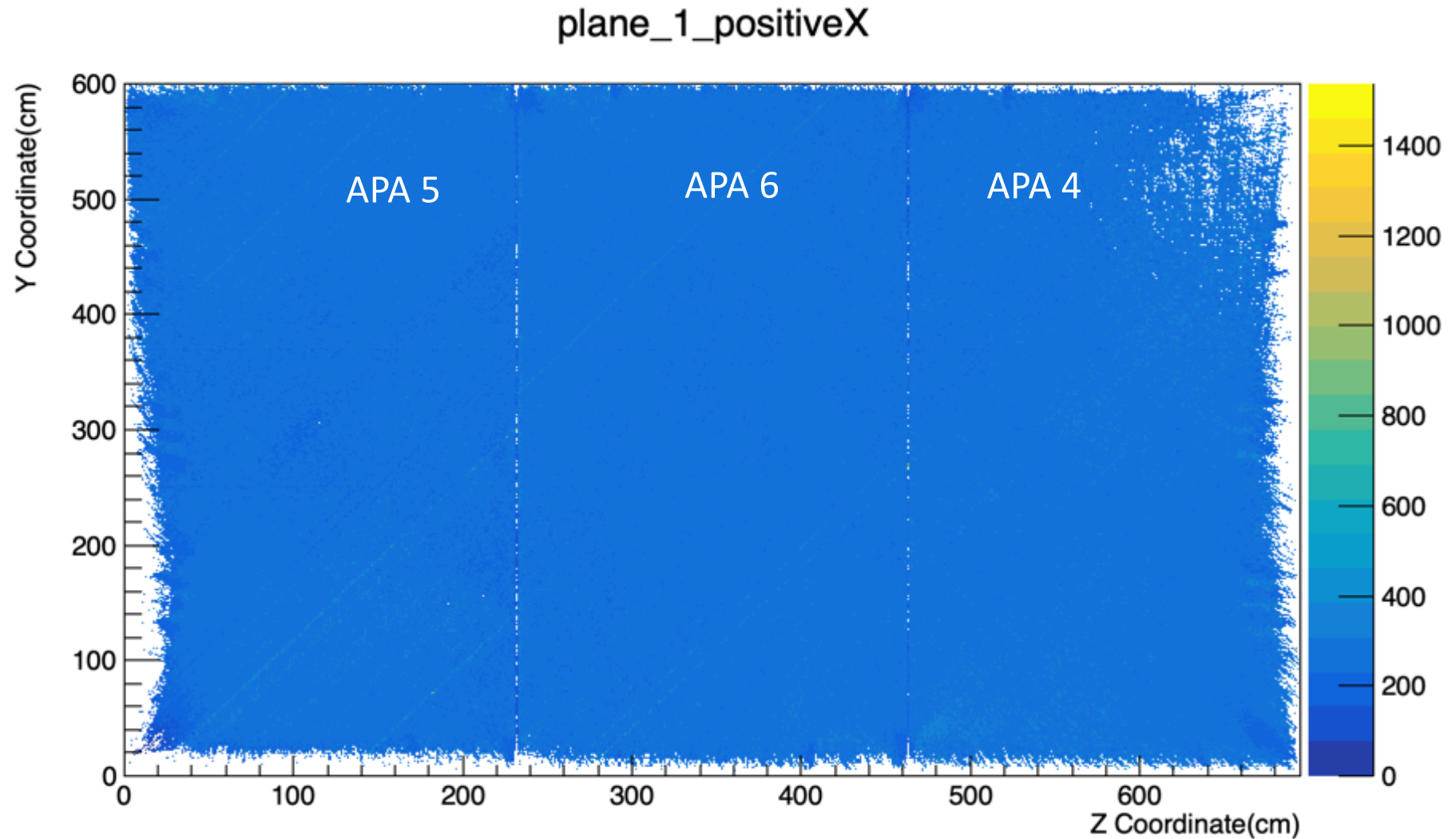
Beam Left

plane_0_positiveX



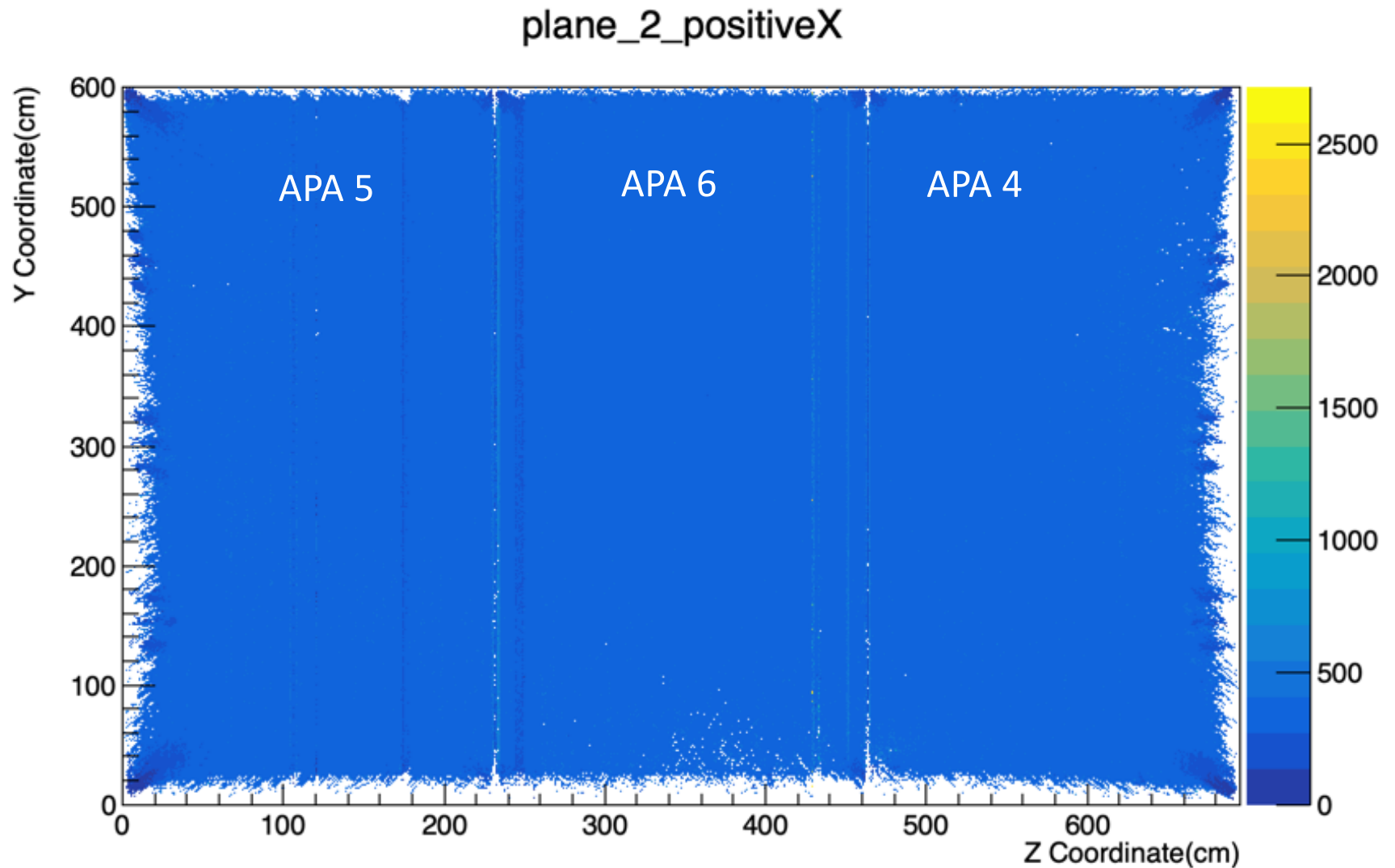
Ajib's Median dQ/dx V plane (y,z)

Beam Left



Ajib's Median dQ/dx Z plane (y,z)

Beam Left



Projecting These Onto Axes

- Features are small and expected to be hard to detect.
- Average the median dQ/dx values along axes:

$$U = y \sin\theta - z \cos\theta$$

$$V = y \sin\theta + z \cos\theta$$

(swap U and V for APA's 4, 6 and 5)

Z

Y

- Do this for each plane's data in each APA:
(U, V, Z) x (1,2,3,4,6,5) x (4 projections) = 72 plots

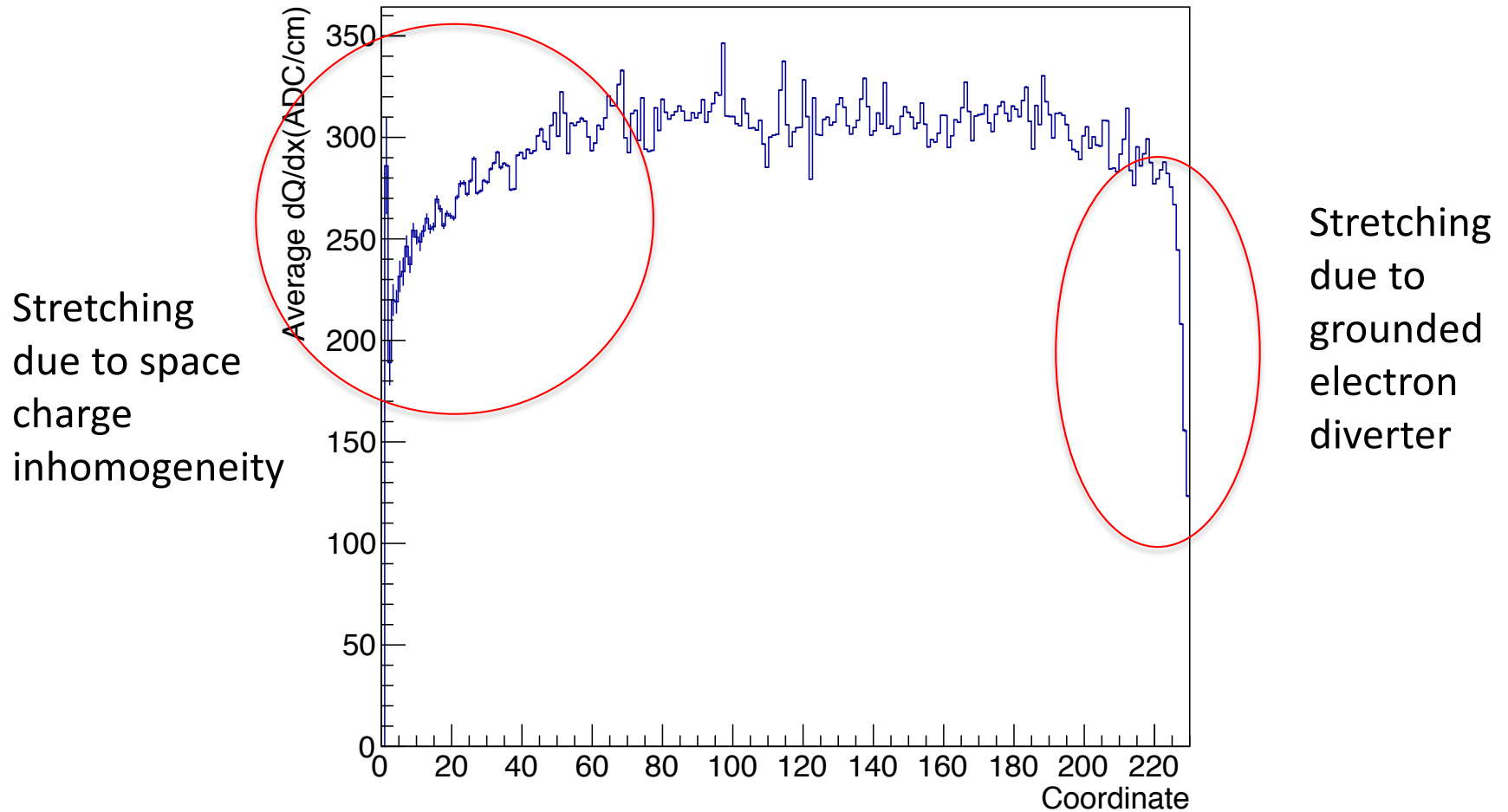
[http://home.fnal.gov/~trj/foralberto/protodune dqdx averages/index.html](http://home.fnal.gov/~trj/foralberto/protodune_dqdx_averages/index.html)

Comments

- These are the dQ/dx values for hits that are seen, not a count of missing ones. So an upward spike upwards due to displaced charge is coupled with a downward dip that doesn't show up on these plots.
- U wires are at constant U. V wires are at constant V. Collection wires are at constant Z.
- Cryostat-side wire segments do not contribute (to a good approximation)
- Some effects are due to short wires in corners only sampling signals drifting in corners. These can be in the middle of some plots.
- Data are sparse on the edges and corners.

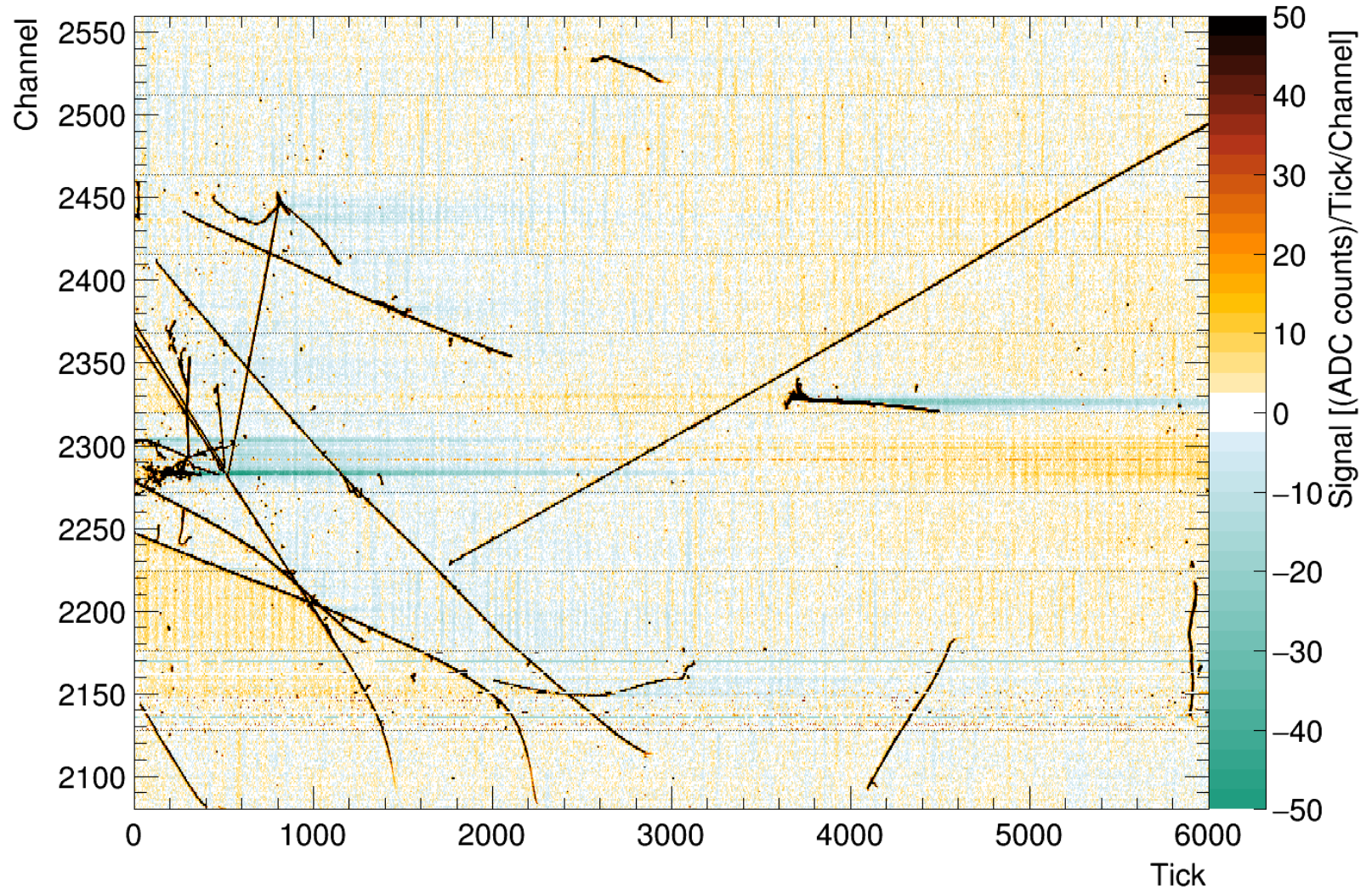
Some Interesting Ones

APA: 3 Signal plane: Z Binned in Z



Space Charge Position Distortion

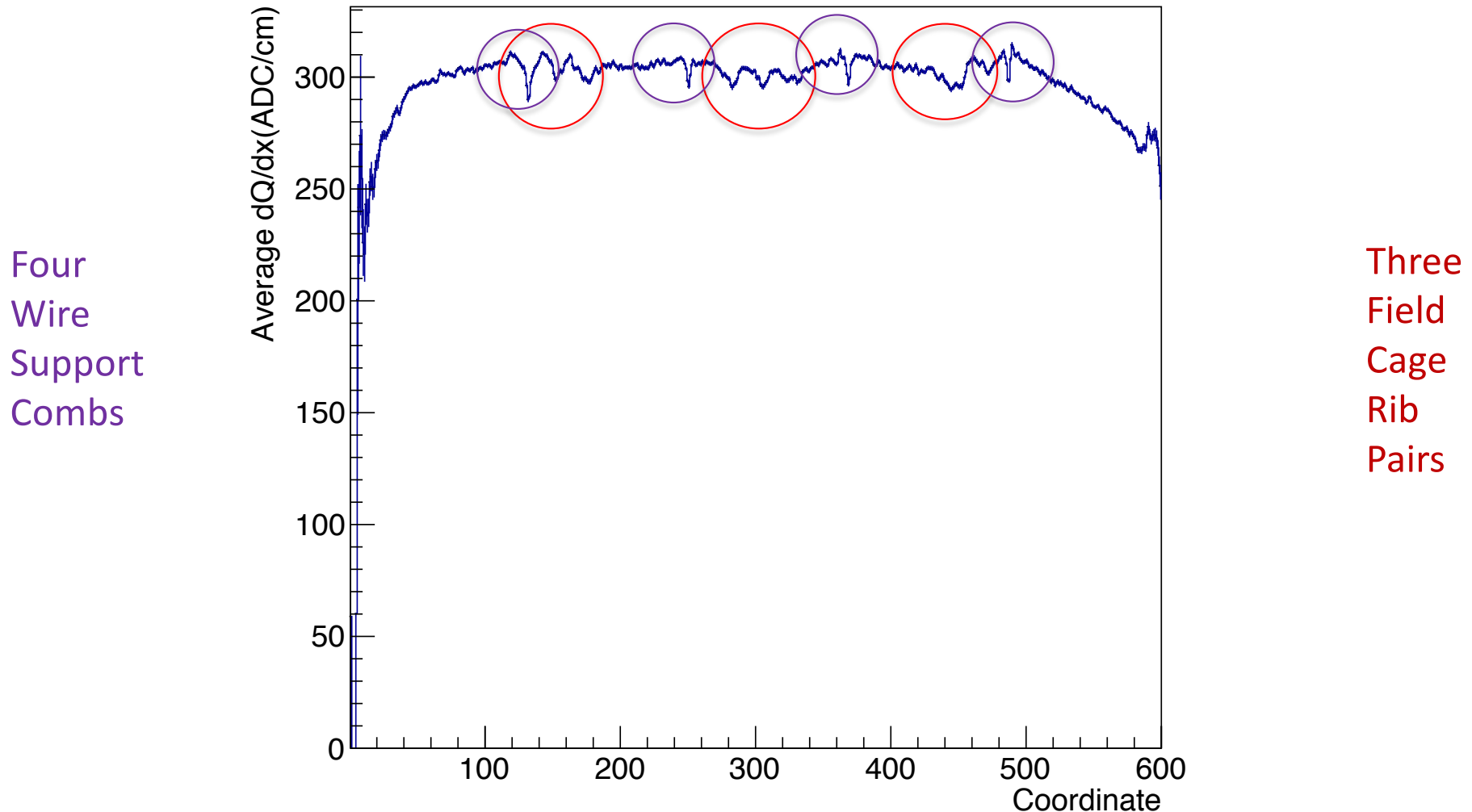
Raw ADC for run 5177 event 305 TPC plane 0z (APA 3: US-RaS) Trigger 8



David Adams's Raw Event Display shows this effect nicely.

Some Interesting Ones

APA: 3 Signal plane: Z Binned in Y



Wire Support Combs

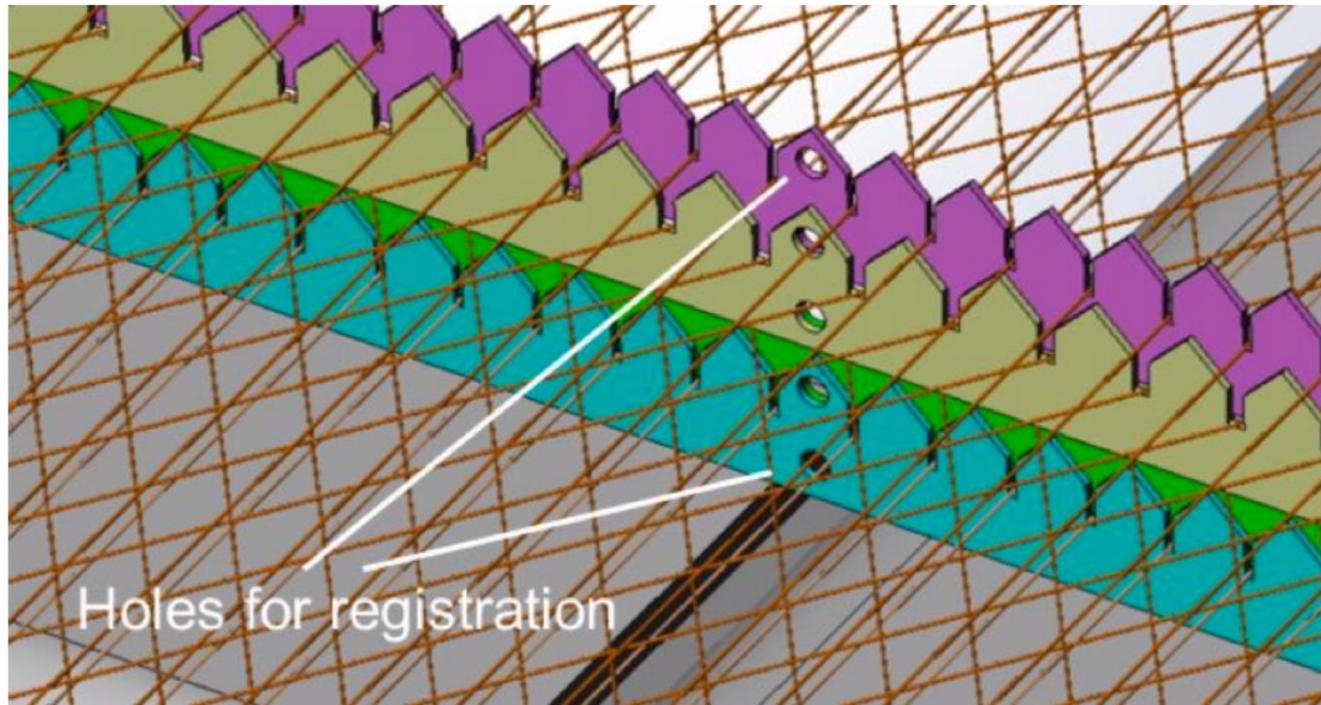


Figure 2.10: A model of the combs showing how they stack. After winding a layer, the comb for the next layer is put in place. Each comb holds the wires from the previous layer in its slots.

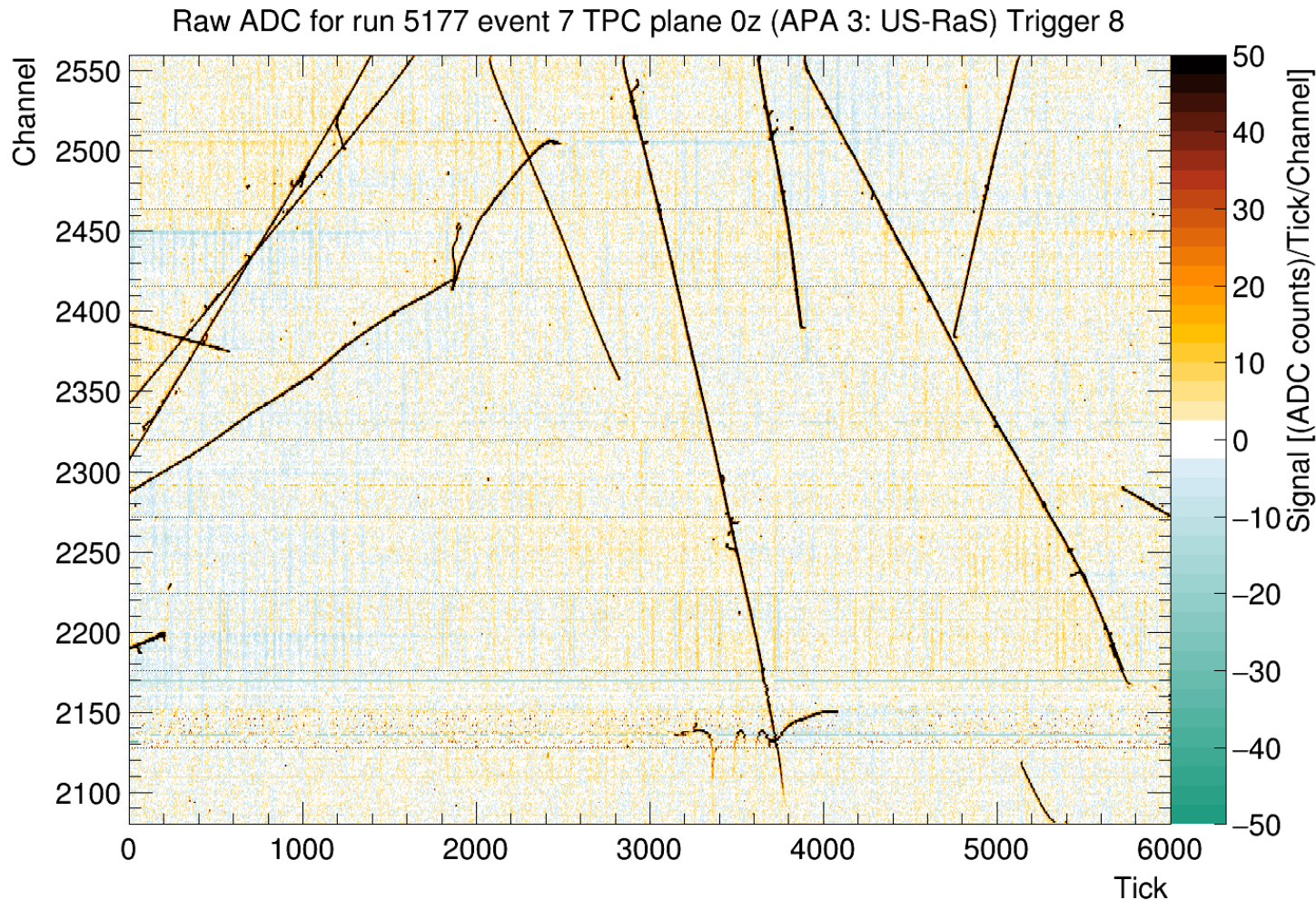
From the ProtoDUNE-SP TDR

Field Cage Ribs and Support Combs



From Kevin
Wood's
Collab
Meeting
Talk
Sep 2018

Track Distortion due to Field Cage Nonuniformities

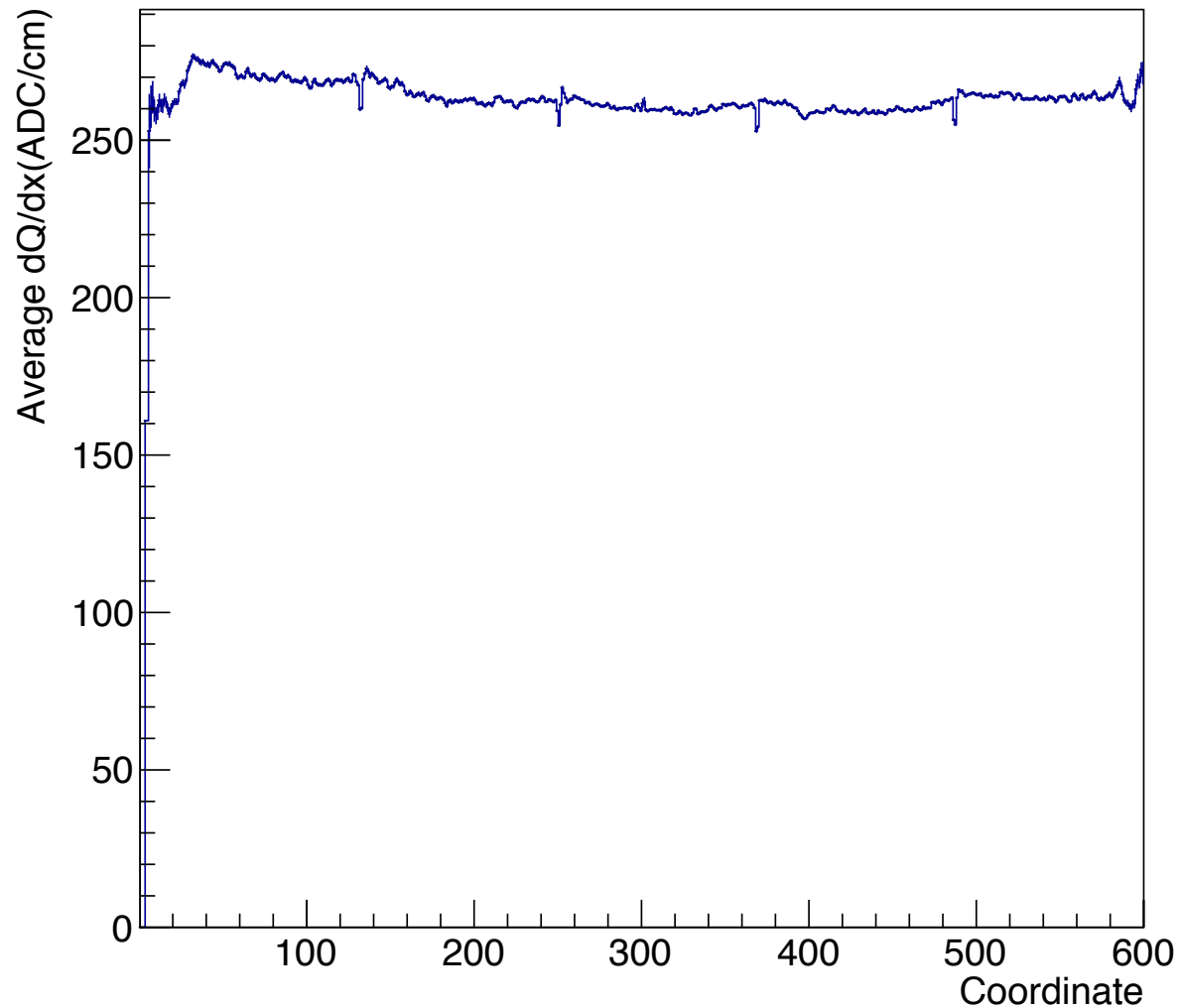


We didn't see this on all tracks – now it makes more sense – these are field cage ribs.

D. Adams

One in the middle – no field cage or diverters

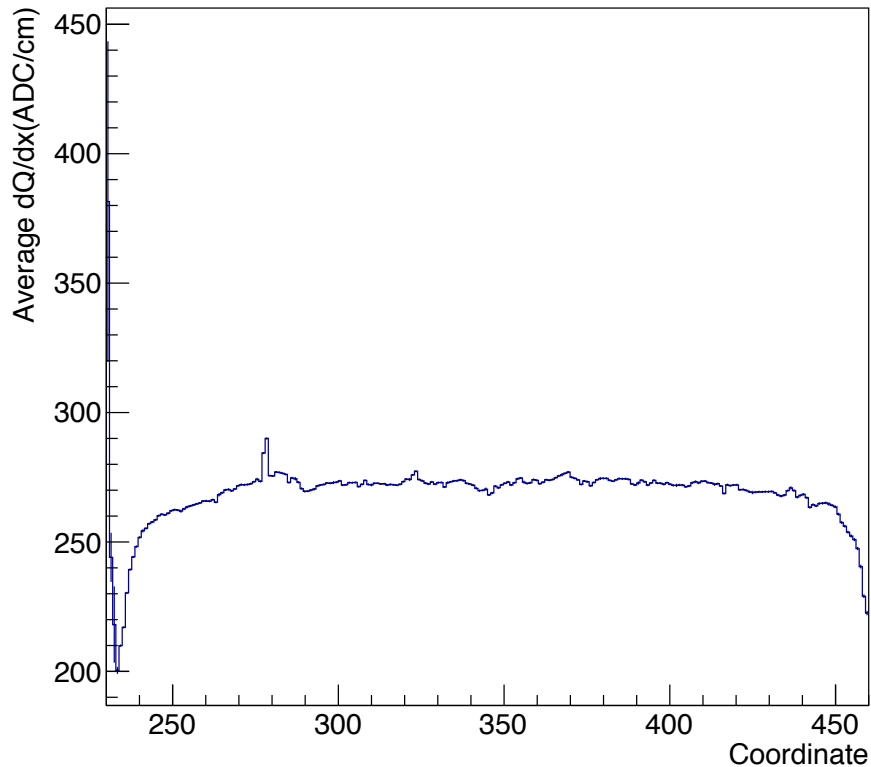
APA: 6 Signal plane: V Binned in Y



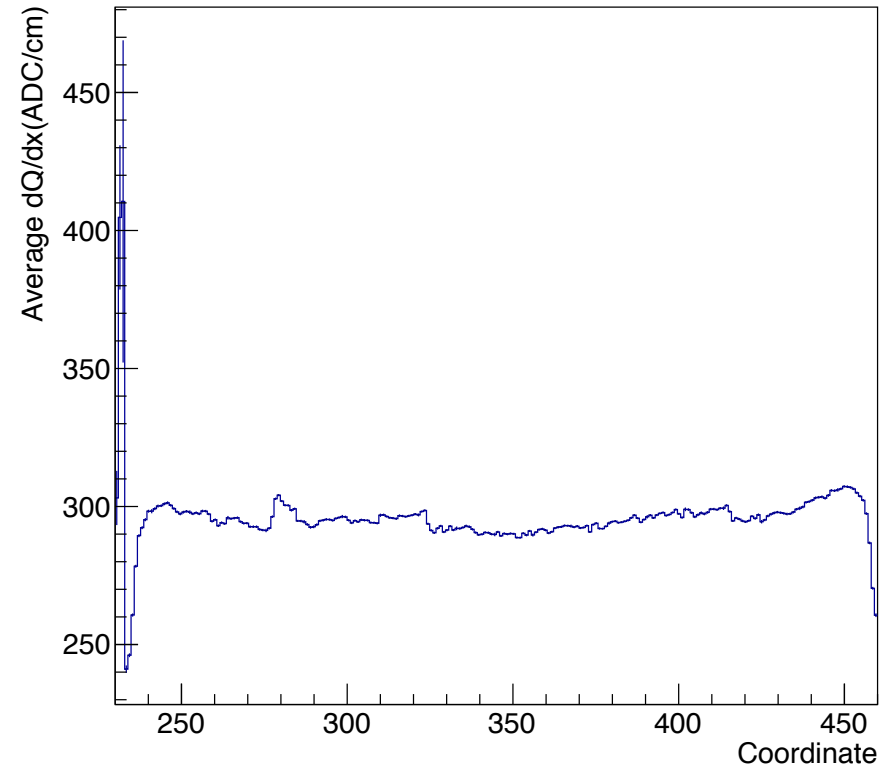
Just the
support
comb effects
visible

An Induced Effect

APA: 2 Signal plane: V Binned in Z



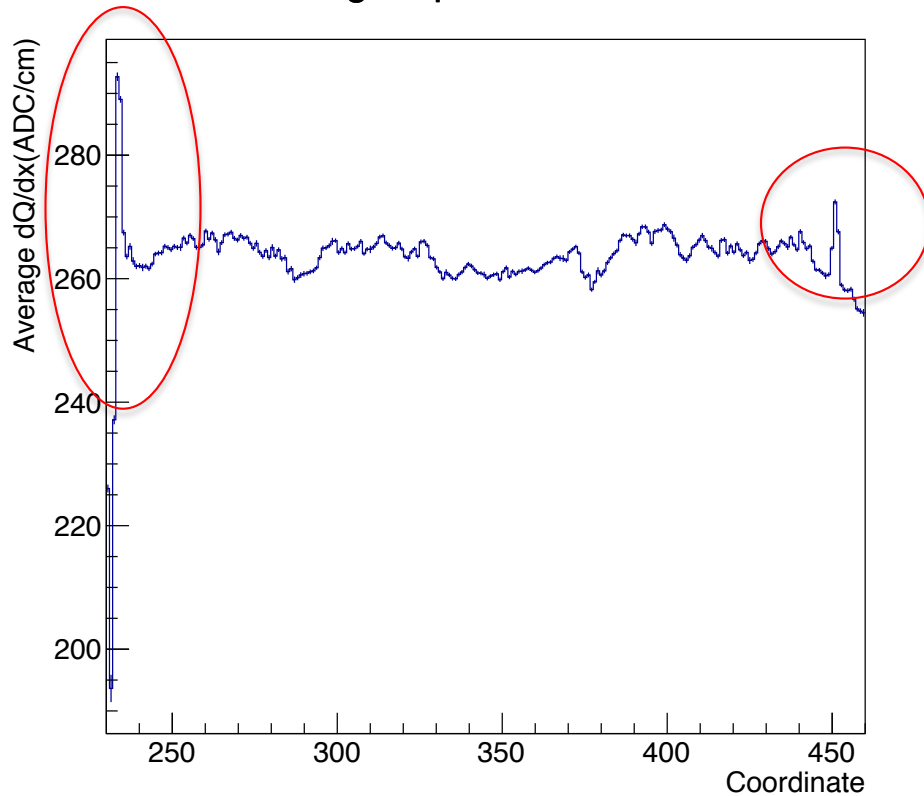
APA: 2 Signal plane: U Binned in Z



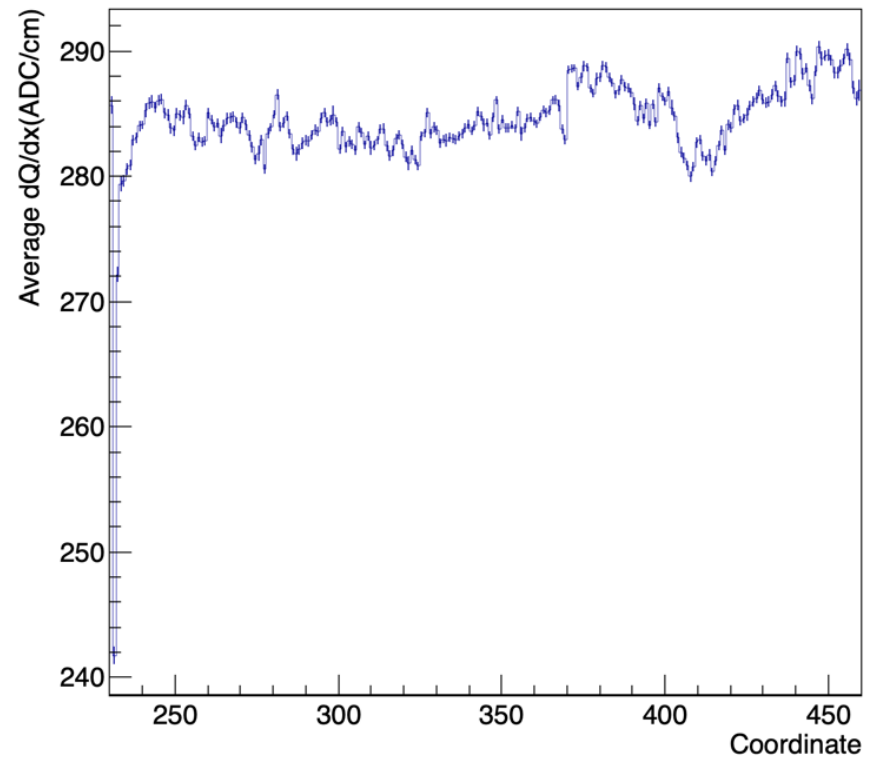
Electron Diverters on each side
Broken collection-plane wire on drift side

Another Pair of Induced Effects

APA: 6 Signal plane: V Binned in Z



APA: 6 Signal plane: U Binned in Z

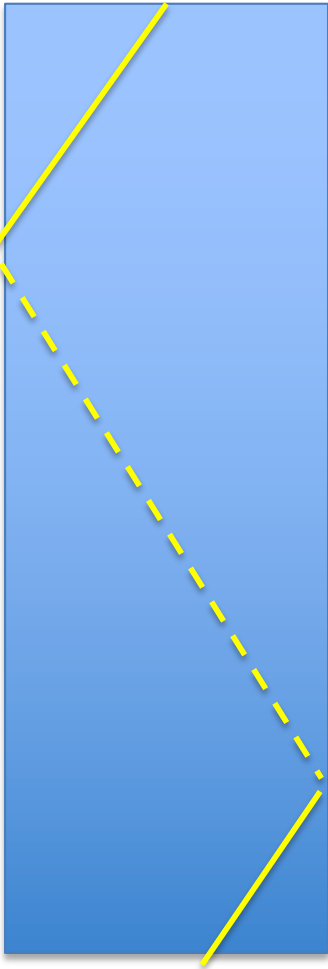
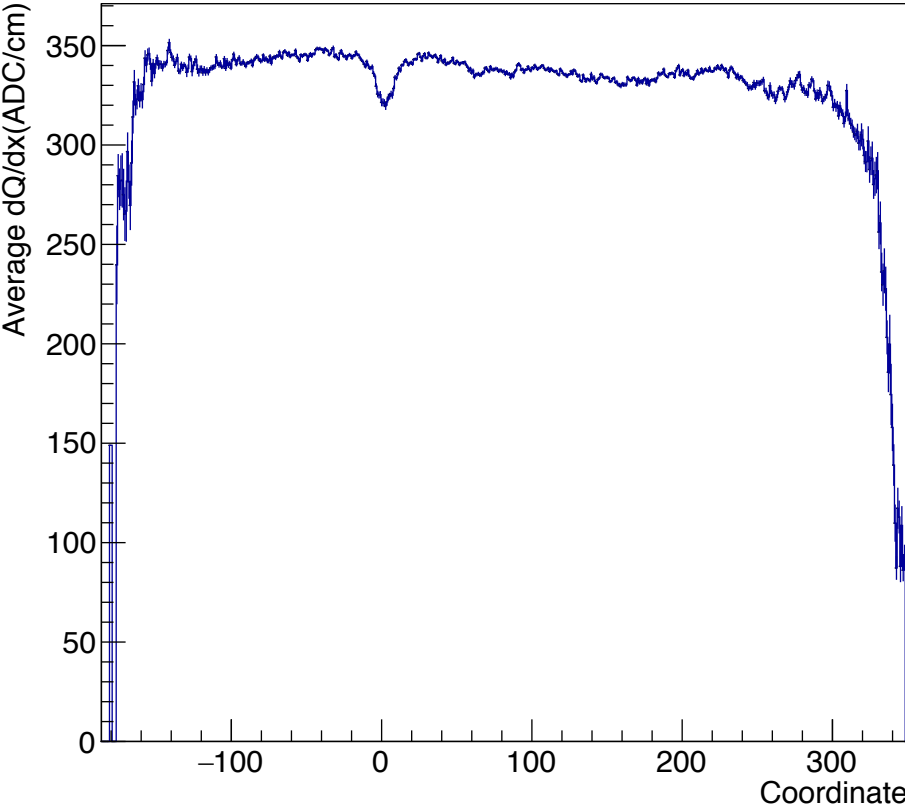


Two broken channels in Z seen in V but not U

Binning done in U and V, not in channel number

Space Charge Effects

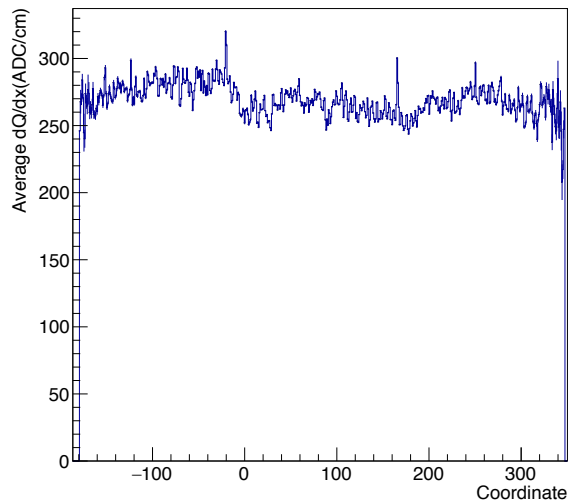
APA: 5 Signal plane: Z Binned in V



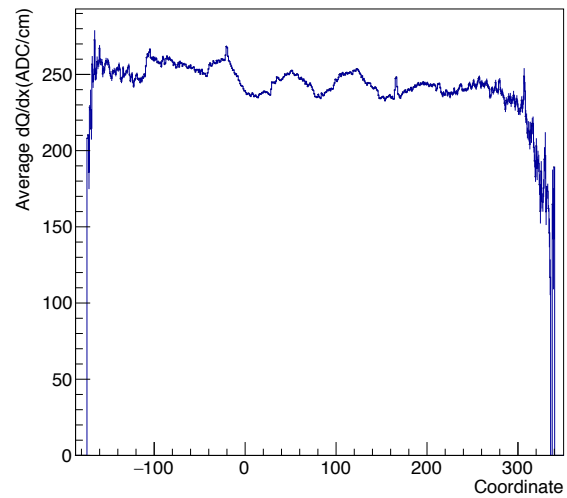
Small signals seen in corners.

Some Effect of Broken U wires

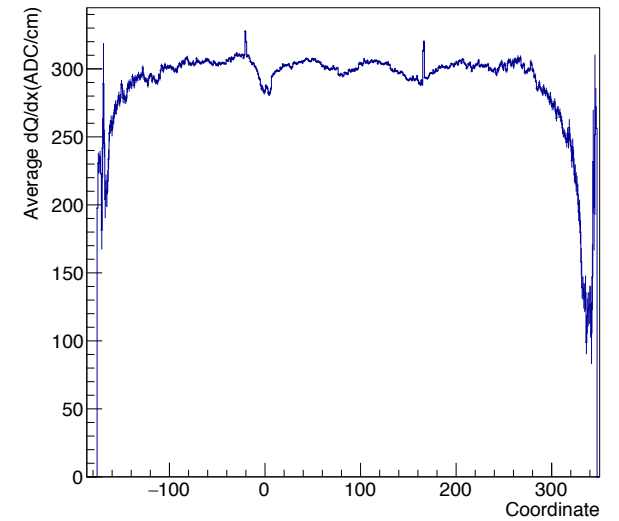
APA: 3 Signal plane: U Binned in U



APA: 3 Signal plane: V Binned in U

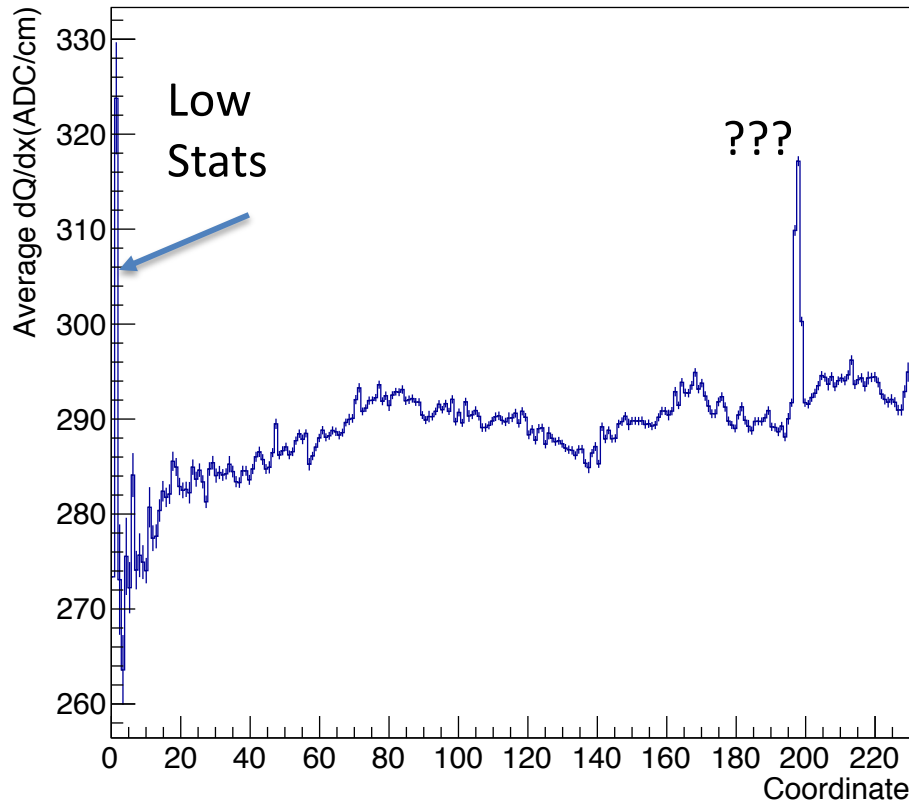


APA: 3 Signal plane: Z Binned in U

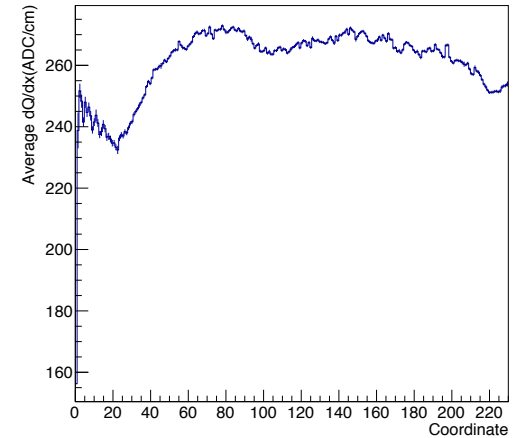


Something Unexpected

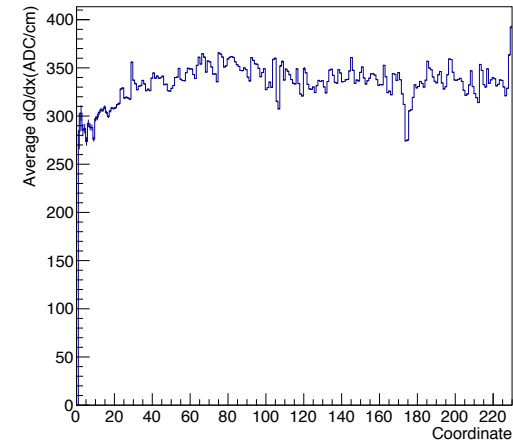
APA: 5 Signal plane: U Binned in Z



APA: 5 Signal plane: V Binned in Z



APA: 5 Signal plane: Z Binned in Z



Grid wire broken? Seen in U but not V when projected in Z
Position not on Tingjun's map

Summary

- More plots (72 combinations) on the web page
- Not all features are understood yet.
- Some of the dead wires on David's list cause induced effects on other planes' signals, but not all. Effects are small
- Space charge spreads out and lowers dQ/dx .
- Space charge effects are large.
- Field cage ribs and combs have small but visible effects