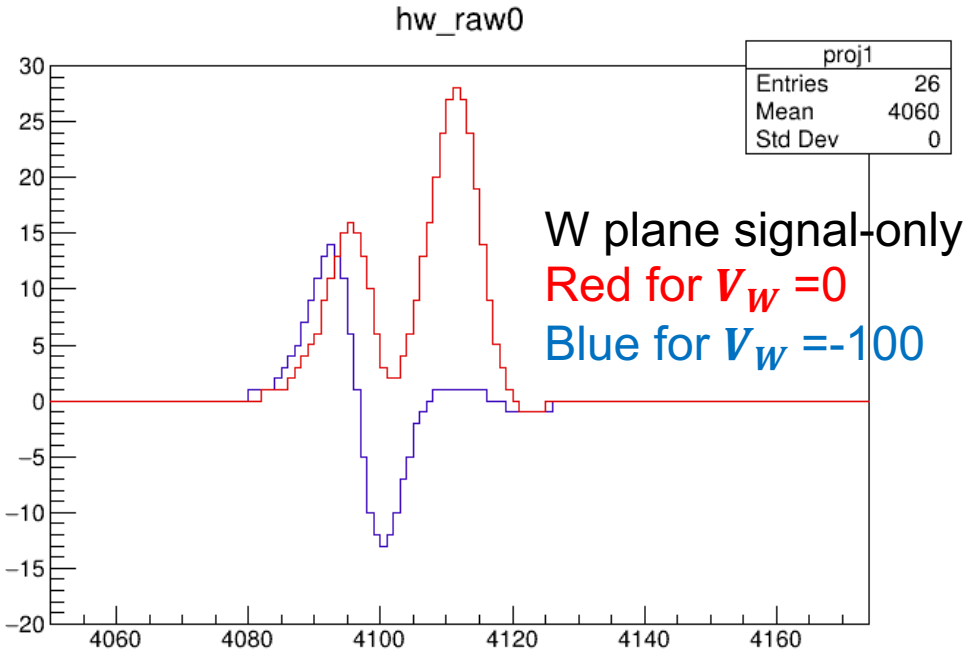
Update on field response check

Xuyang Ning & Wenqiang Gu

11/07/2024

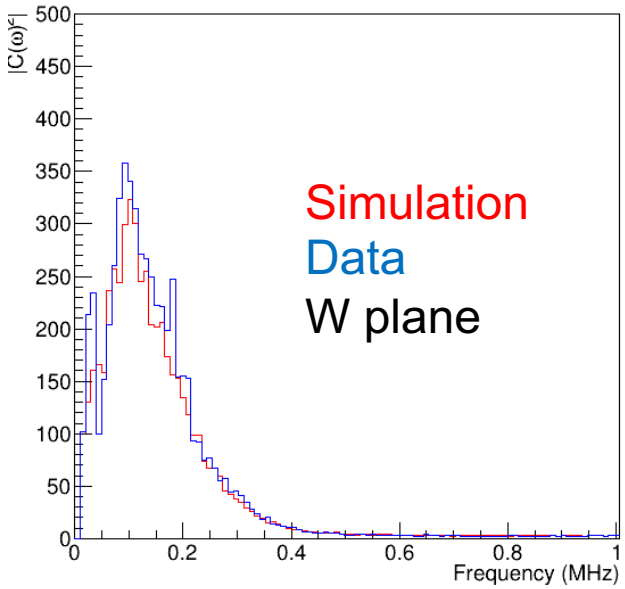
Brookhaven National Laboratory

Set V_W =-100V

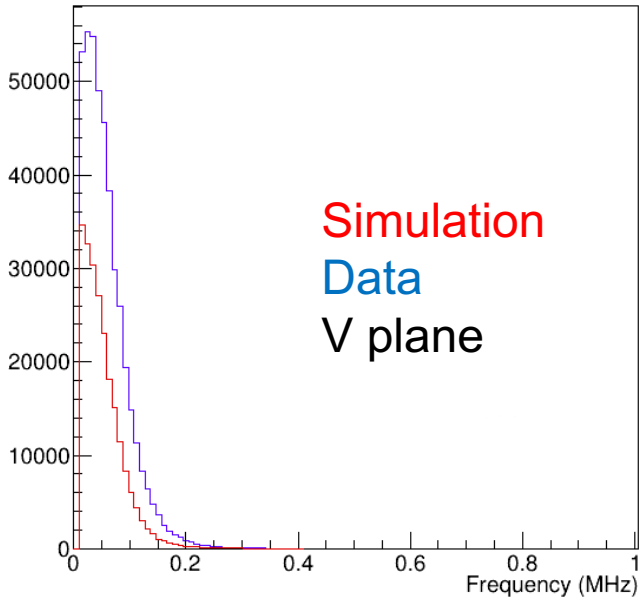


W plane signal-only simulation
Red for V_W =0
Blue for V_W =-100

power spectra in beam direction

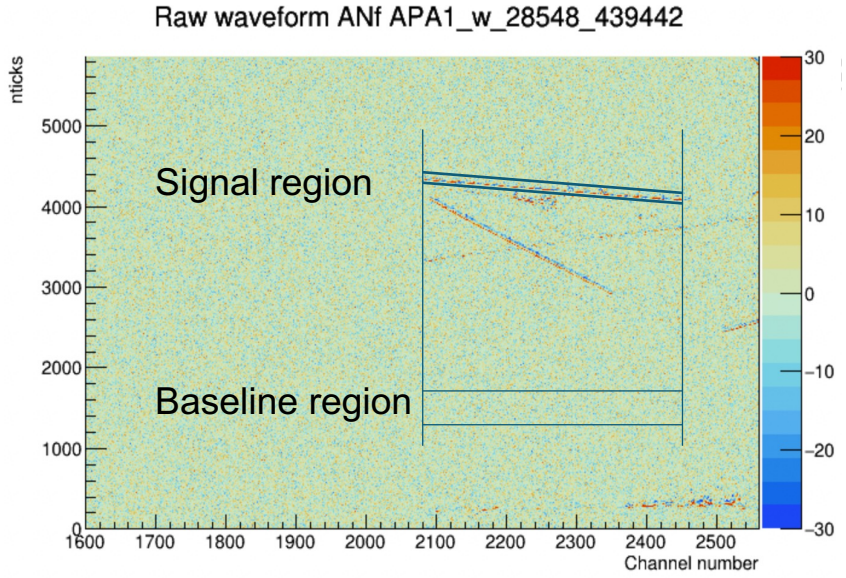


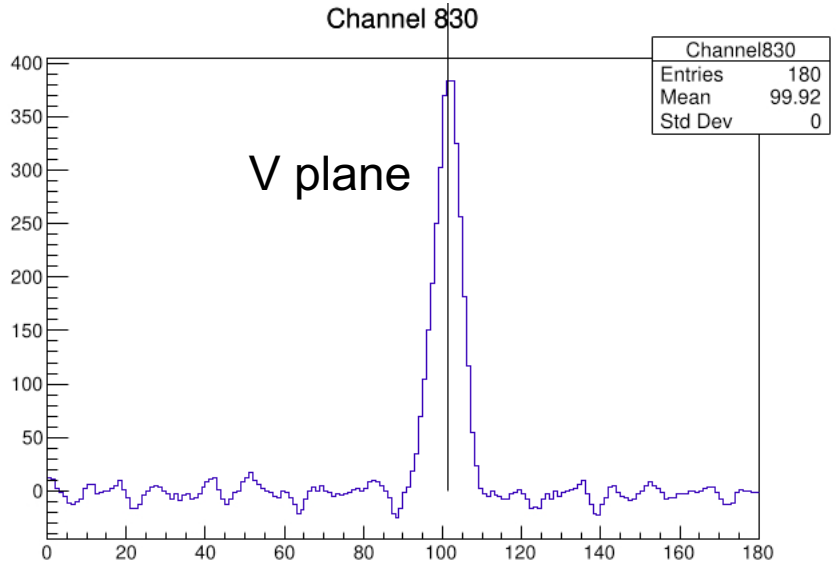
Simulation
Data
W plane

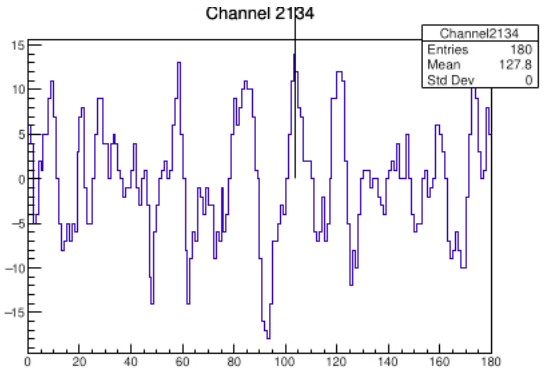


Simulation
Data
V plane

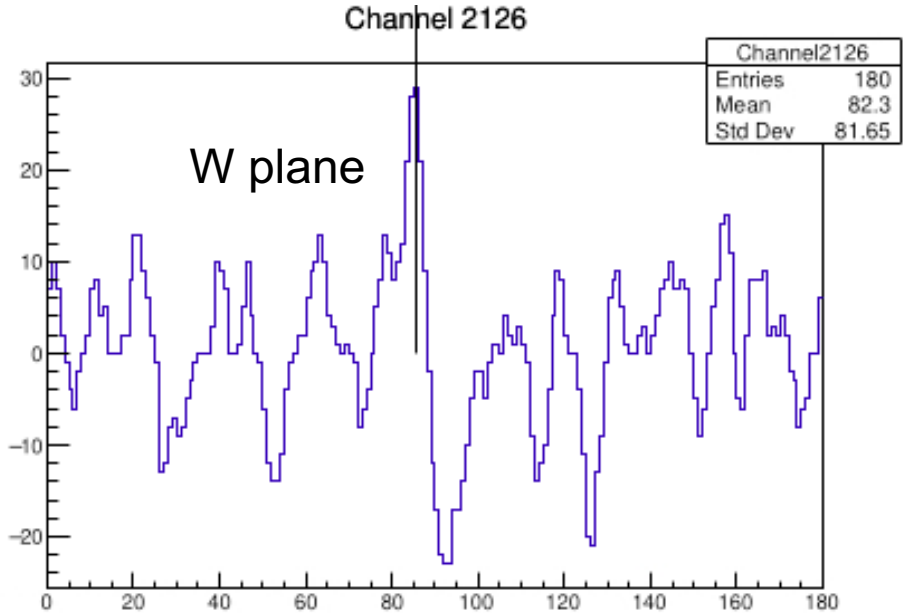
Align signal from Data







Fail situation



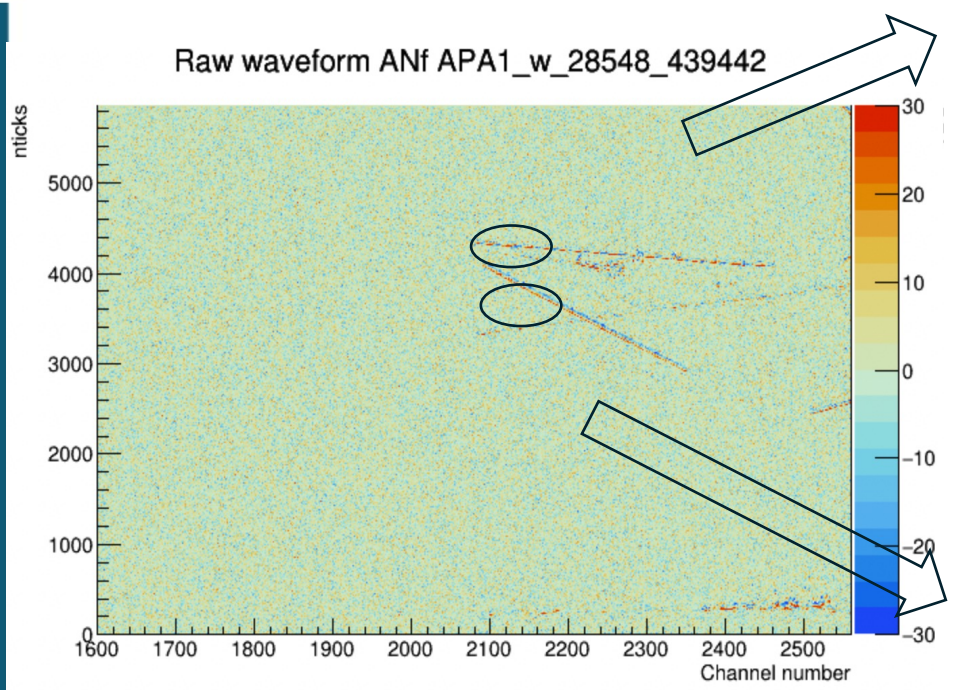
Align signal:

- Cut a small region with pure signal
- Find the maximum bin, regard it as the peak of the signal (sometimes fail for w plane but not much)
- Align all the peaks.

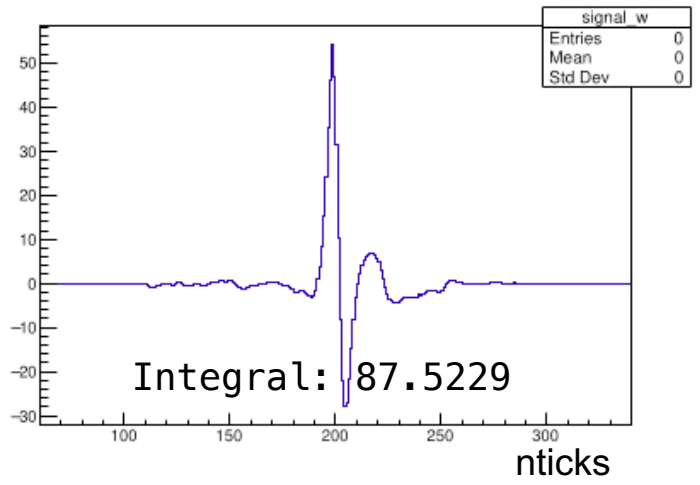
Baseline:

- Same channels as selected signals
- Average along the channels
- (Just to see if it is near 0)

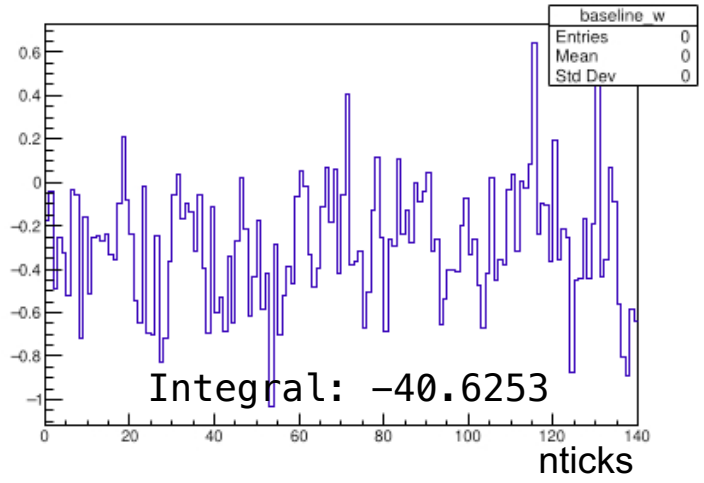
Align signal from Data; w plane



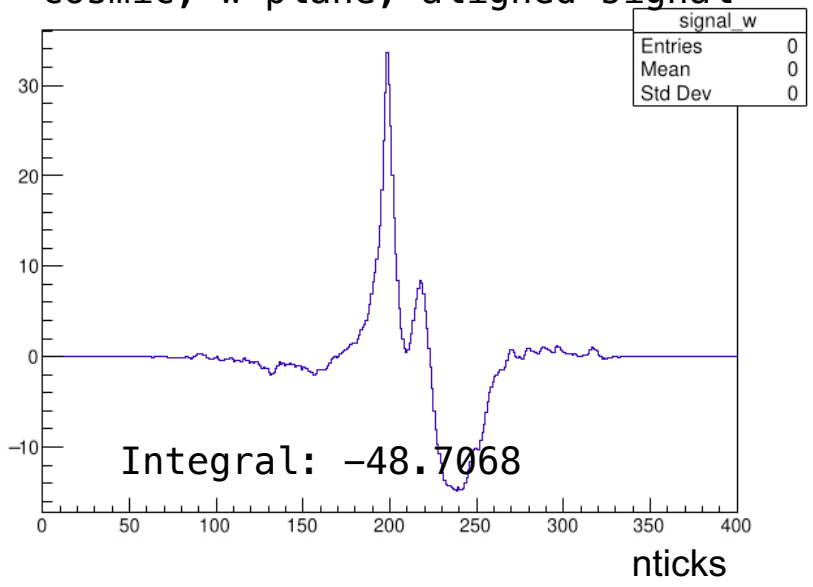
Beam; w plane; aligned signal



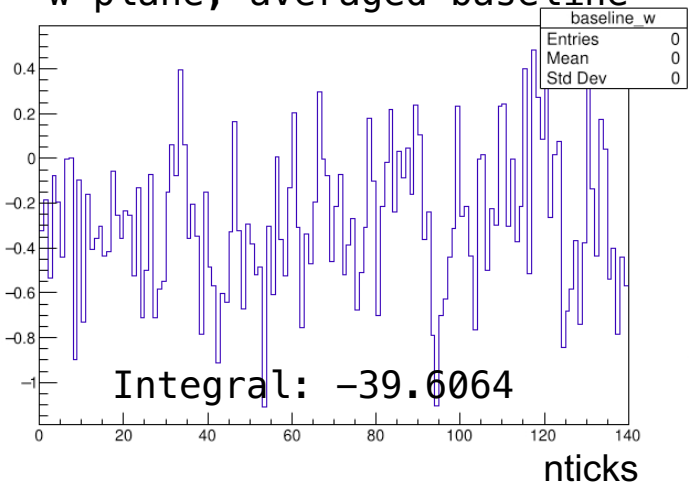
w plane; averaged baseline



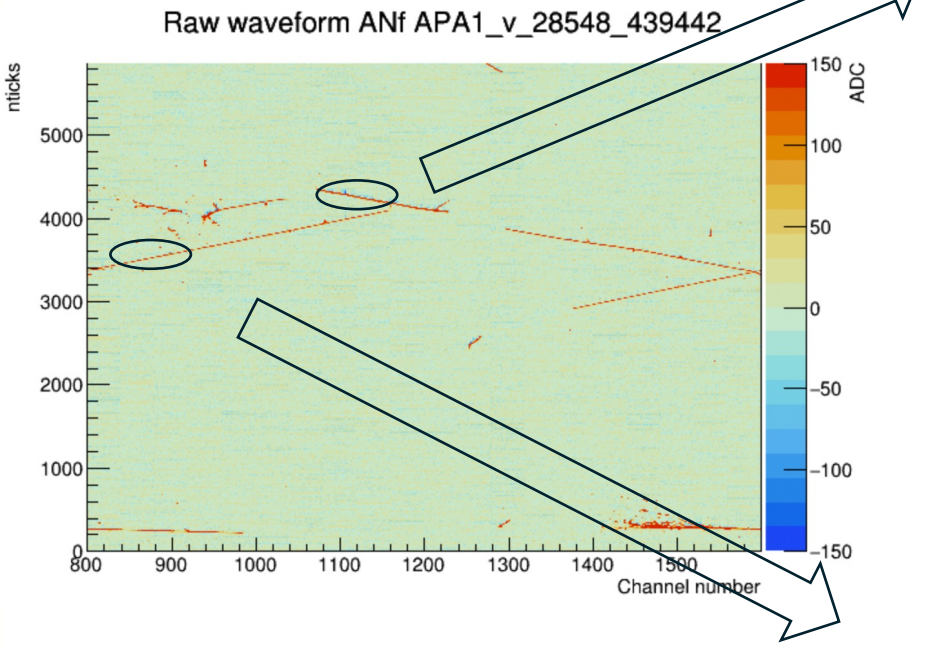
Cosmic; w plane; aligned signal



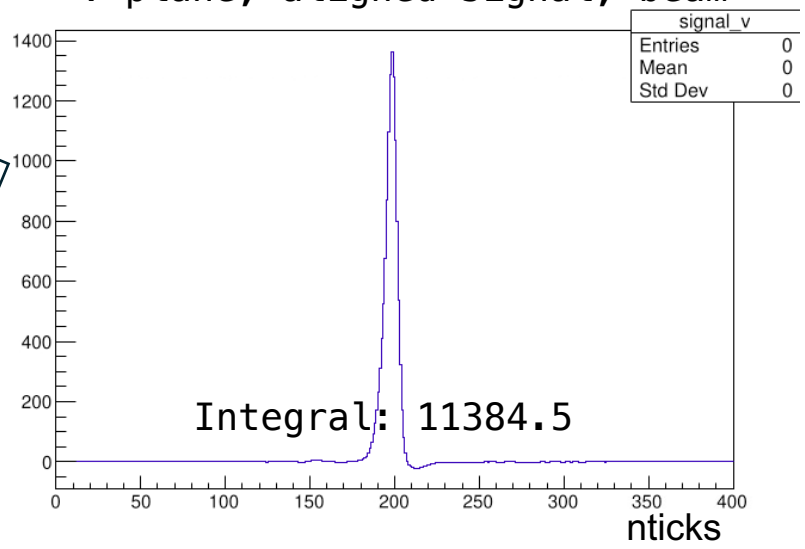
w plane; averaged baseline



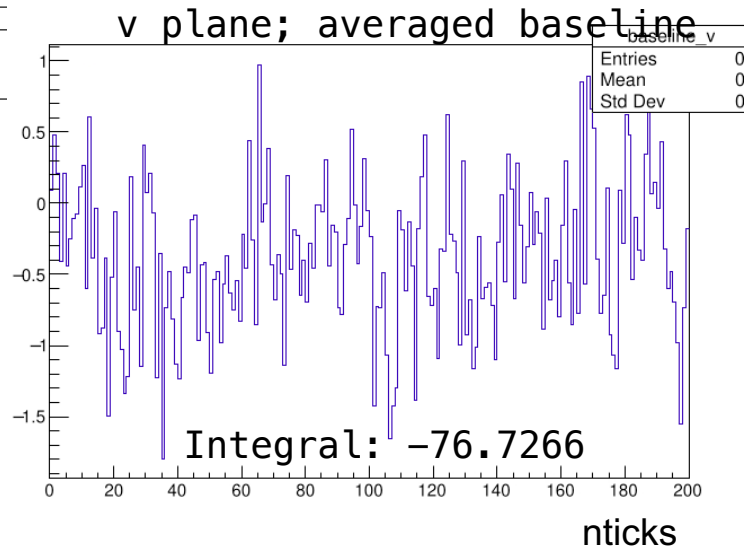
Align signal from Data; v plane



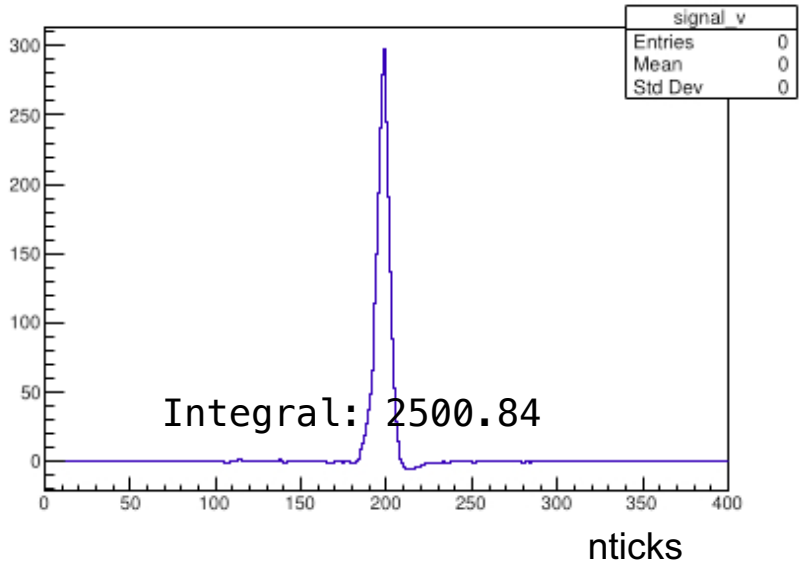
v plane; aligned signal; beam



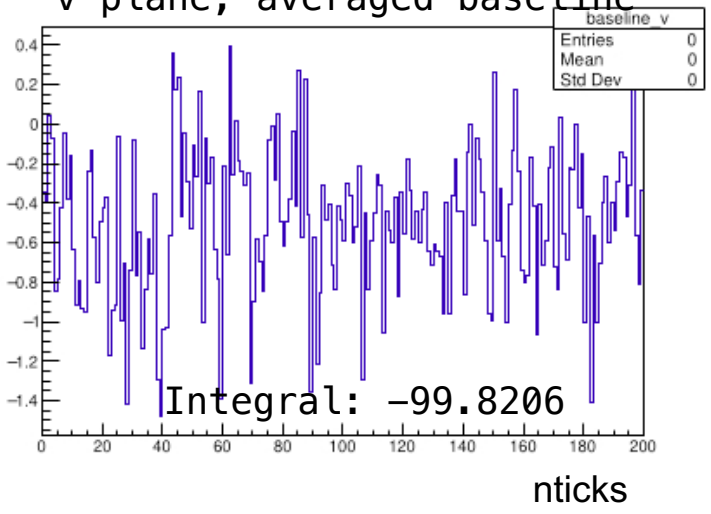
v plane; averaged baseline



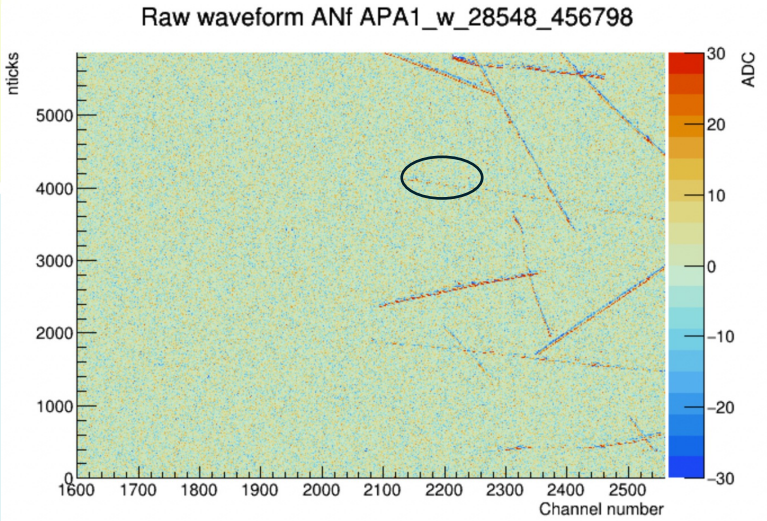
v plane; aligned signal; cosmic

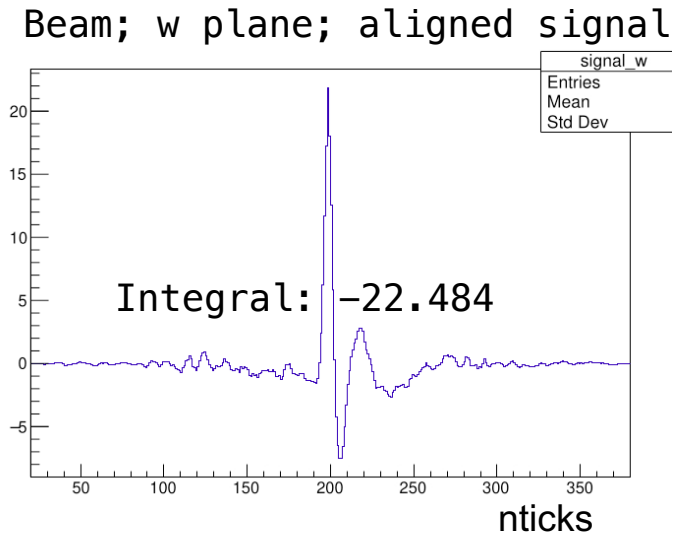


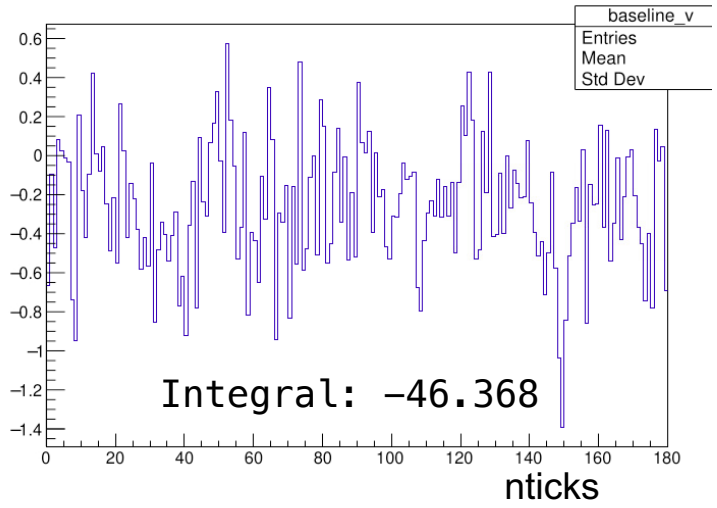
v plane; averaged baseline

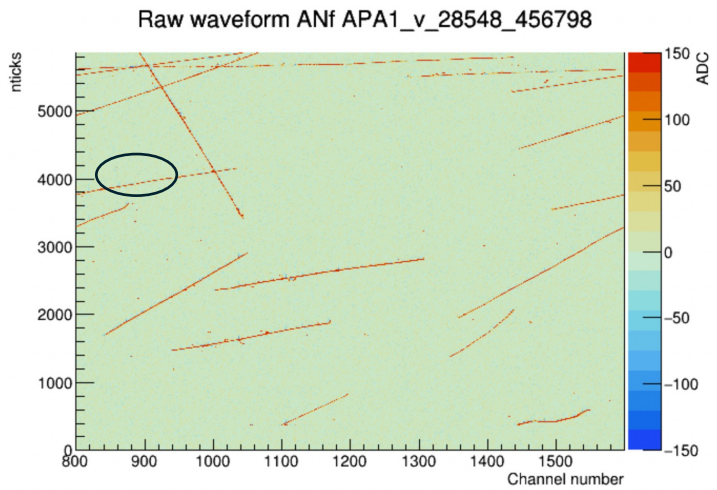


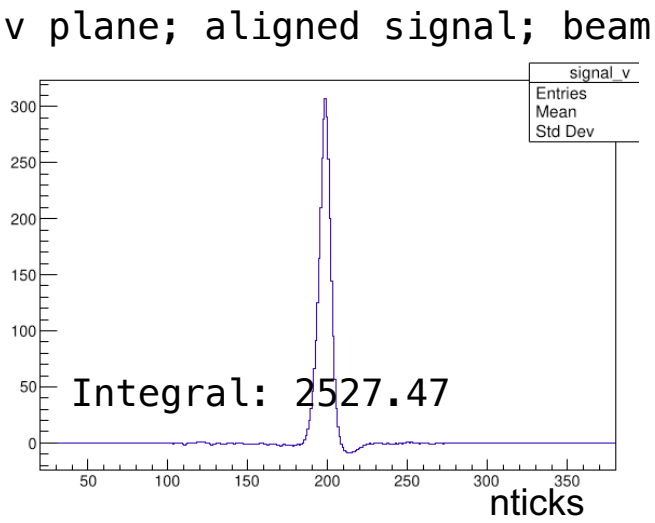
Align signal from Data, another one

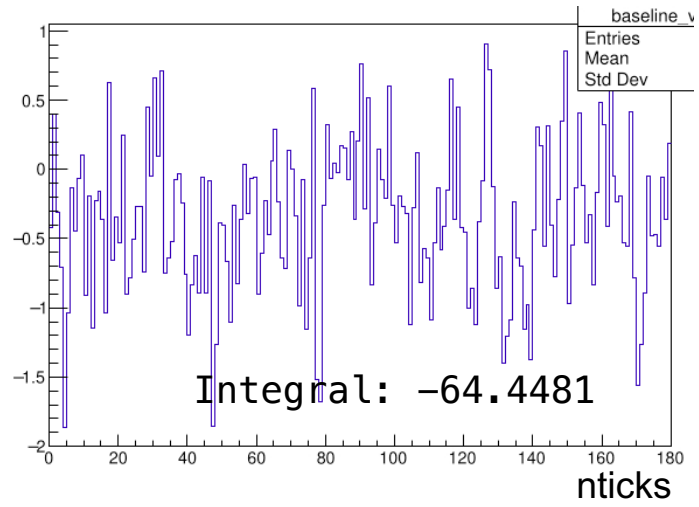






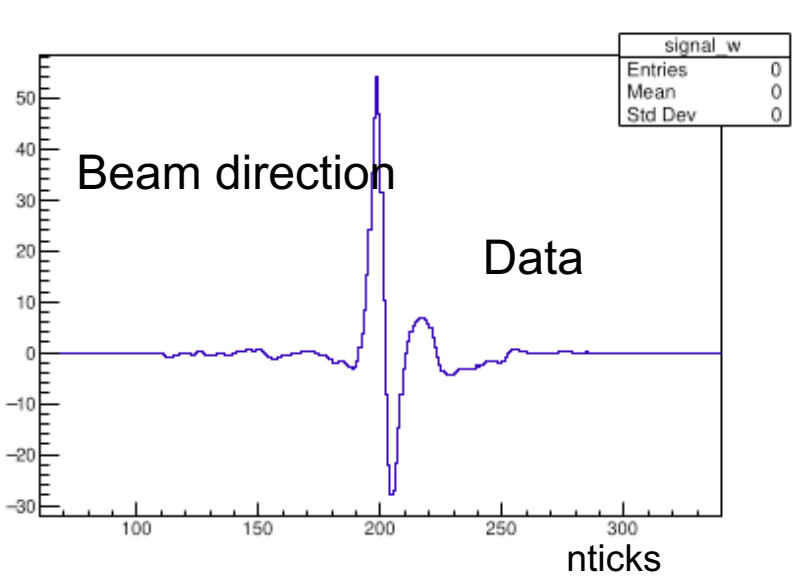


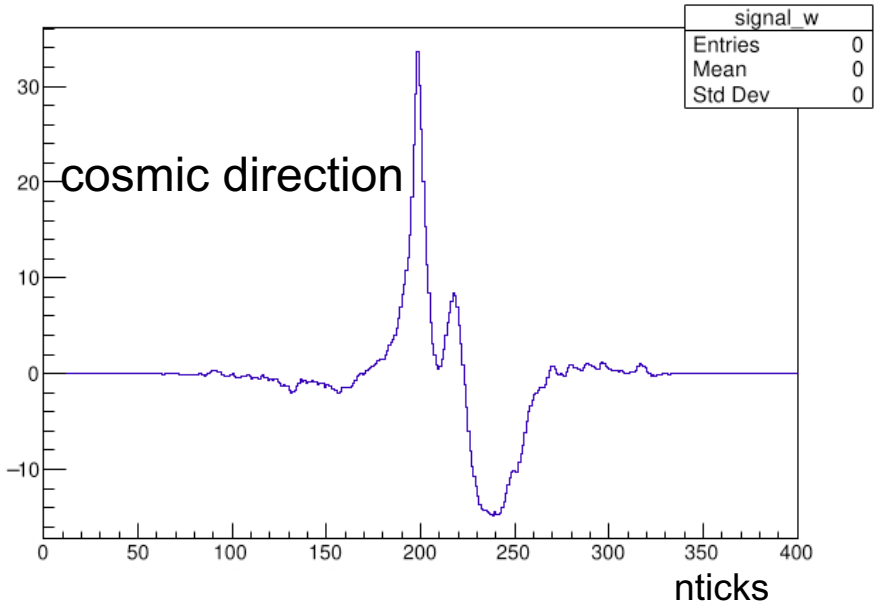




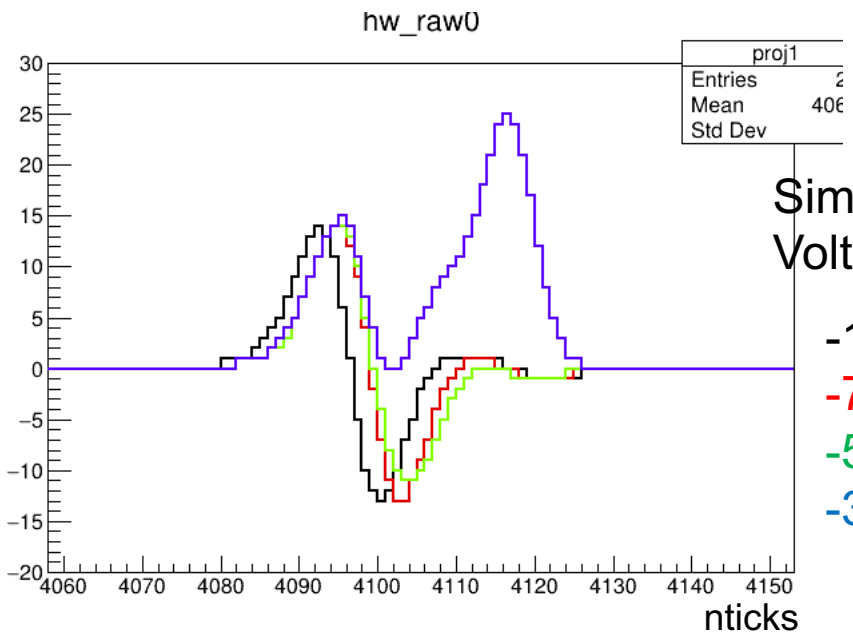
Waveform from Data and simulation

- Asymmetry between positive and negative.
- Double bipolar.



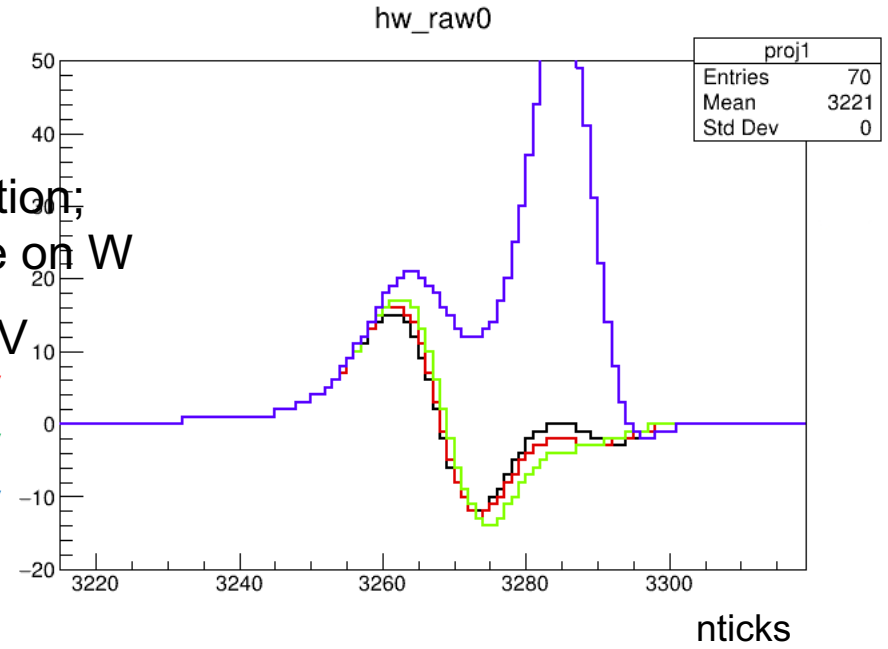


- For simulation, might be a little collection on w, larger collection on mesh

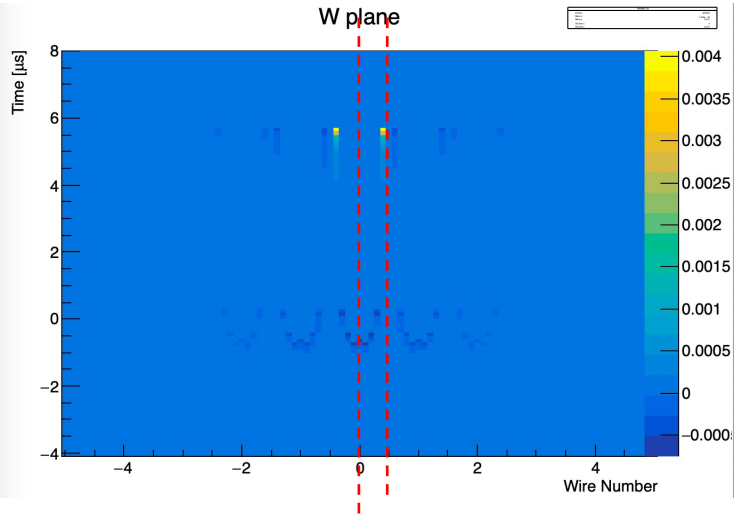


Simulation;
Voltage on W

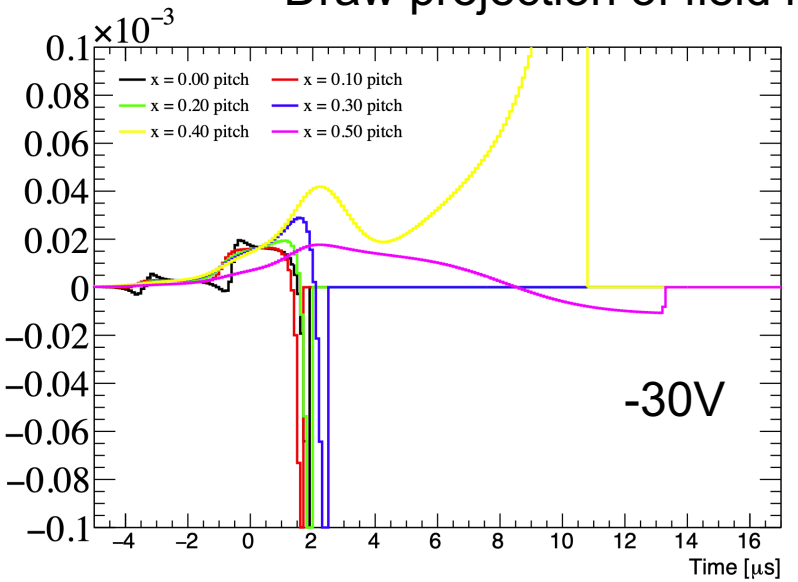
-100V
-70V
-50V
-30V

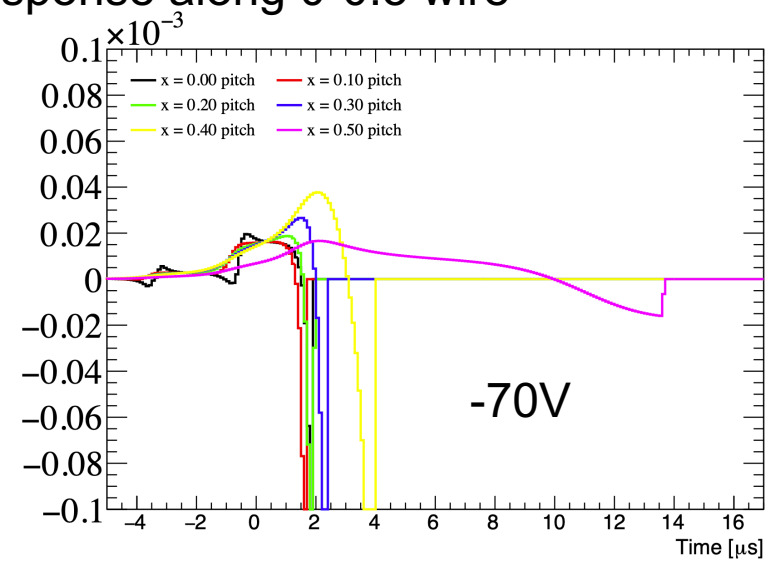


Garfield Simulation

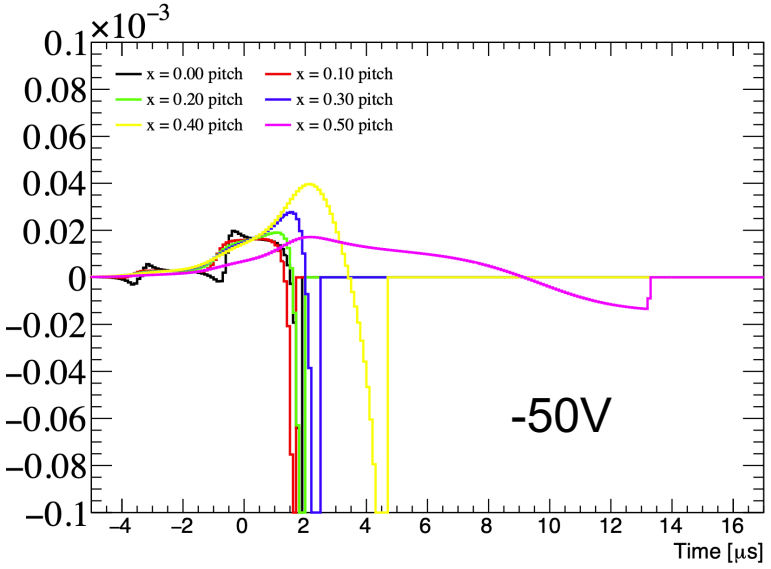


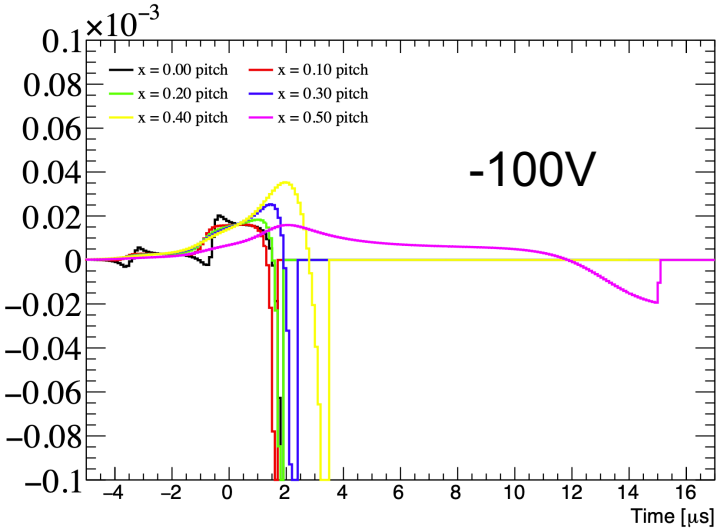
Draw projection of field response along 0-0.5 wire





- Only have 6 electron tracks can be used.
- For different w voltage, 0.4 and 0.5 pitch vary a lot, others are similar.
  - 0.4 pitch: w collected or not
  - 0.5 pitch: mesh collected
- We try to “create” the shape by renormalize the electron track at 0.4 and 0.5 pitch.



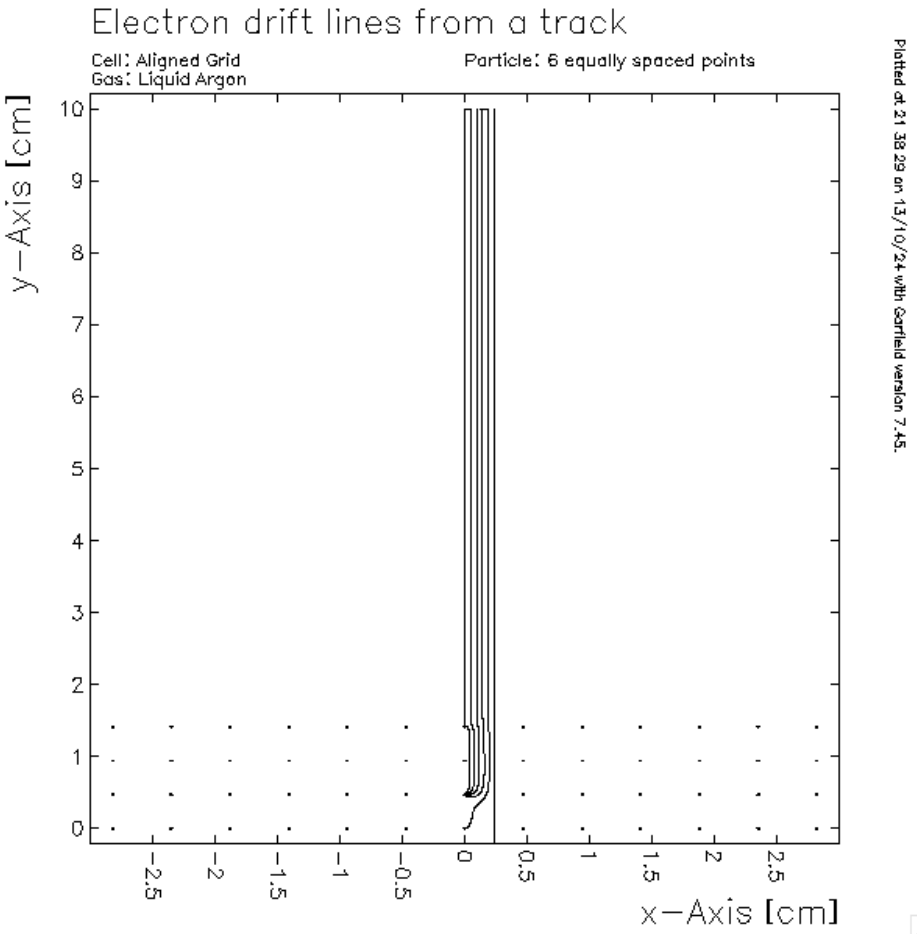


Manually try

- Start with Garfield simulation V_w=0 V
  - 0.4 pitch: w collected
  - 0.5 pitch: mesh collected
- Decrease w collected and increase mesh collected

- Apply same renormalize factor for v and w. So that later we can use v to normalize the amplitude.

- I tried several factors manually; Next page is the best one I got for beam direction.

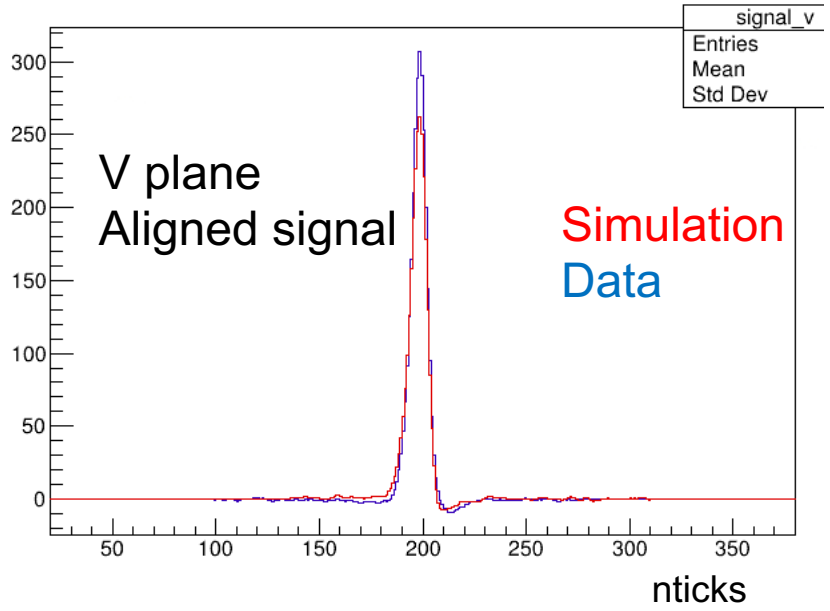


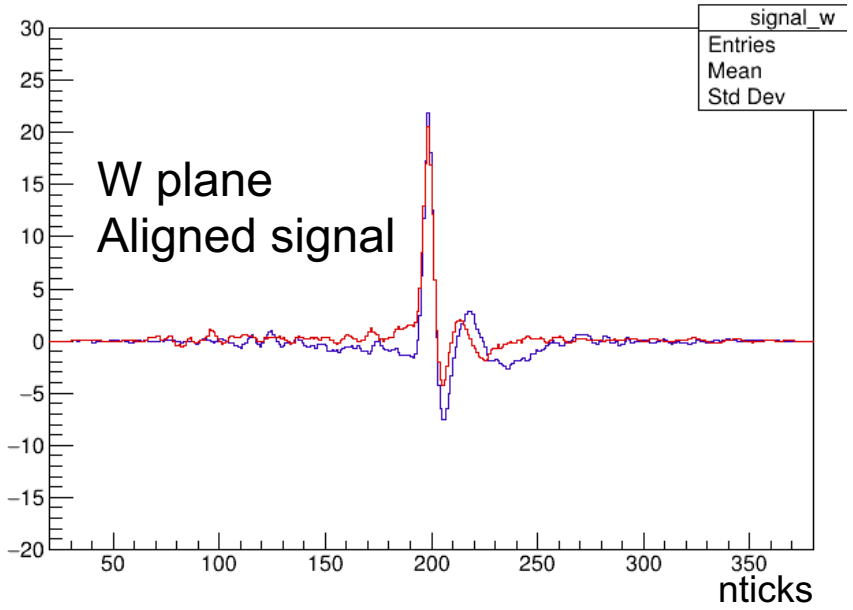

```
        relative_region = one['wire_region'] - zero_wire_region
        fix_garfield_impact_sign = -1
        impact_number = fix_garfield_impact_sign * one['impact']
        if one['plane'] == 'w' and one['impact'] == 1.884: # impact positions: 0.0, 0.471, 0.942, 1.413, 1.884, 2.355
            rf = response.ResponseFunction(plane, relative_region,
                                           one['wire_region_pos'],
                                           ls, numpy.asarray(one['y'] * 0.01), # renormalize
                                           impact_number)
        elif one['plane'] == 'v' and one['impact'] == 1.884: # impact positions: 0.0, 0.471, 0.942, 1.413, 1.884, 2.355
            rf = response.ResponseFunction(plane, relative_region,
                                           one['wire_region_pos'],
                                           ls, numpy.asarray(one['y'] * 0.01), # renormalize
                                           impact_number)
        elif one['plane'] == 'w' and one['impact'] == 2.355:
            rf = response.ResponseFunction(plane, relative_region,
                                           one['wire_region_pos'],
                                           ls, numpy.asarray(one['y'] * 2), # renormalize
                                           impact_number)
            # print("change weight for w here")
        elif one['plane'] == 'v' and one['impact'] == 2.355:
            rf = response.ResponseFunction(plane, relative_region,
                                           one['wire_region_pos'],
                                           ls, numpy.asarray(one['y'] * 2), # renormalize
                                           impact_number)
        else:
            rf = response.ResponseFunction(plane, relative_region,
                                           one['wire_region_pos'],
                                           ls, numpy.asarray(one['y']),
                                           impact_number)
        this_plane.append(rf)
    this_plane.sort(key=lambda x: x.region * 10000 + x.impact)
    ret += this_plane
```

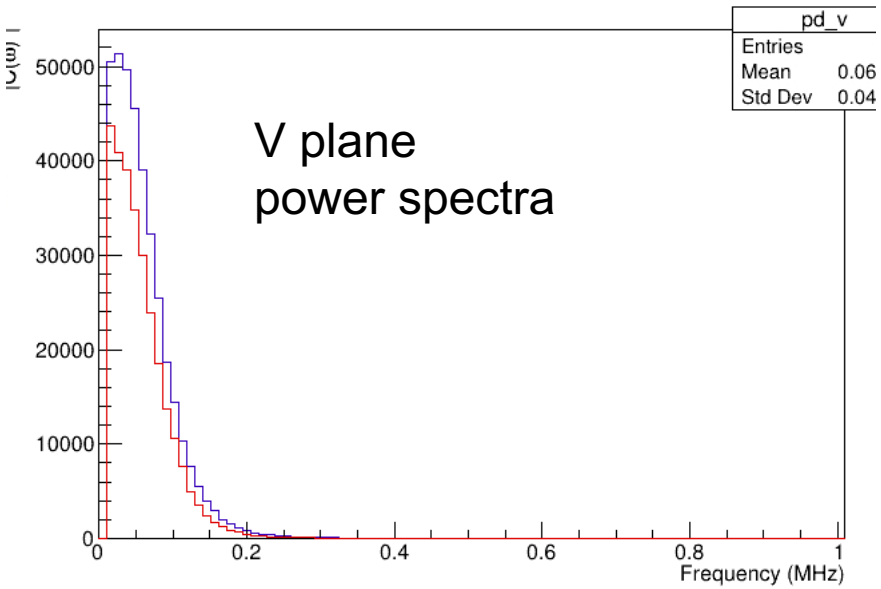
The best one I got for beam direction

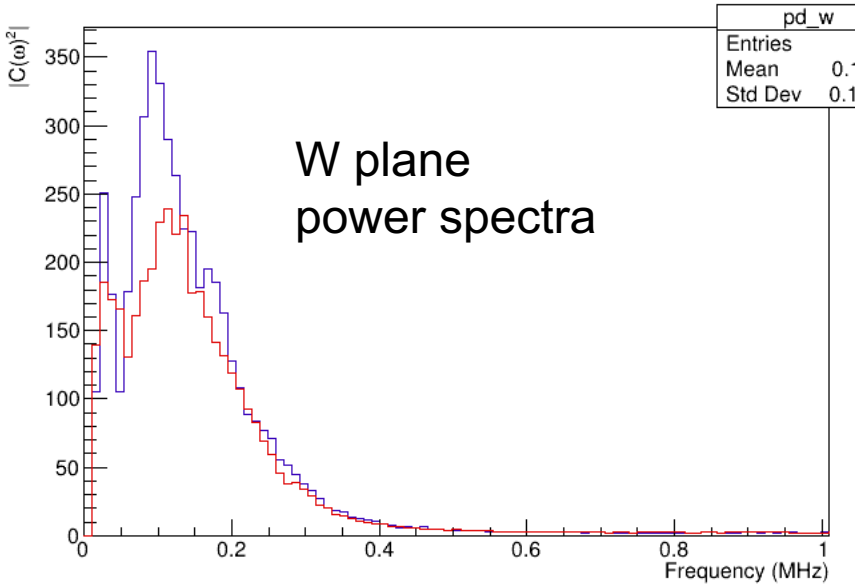
- W collection 0.01
- mesh collection 2

- Compare shape of the signal and power spectra
- Normalize according to v plane
- Electron collected on mesh seem have faster speed than data.

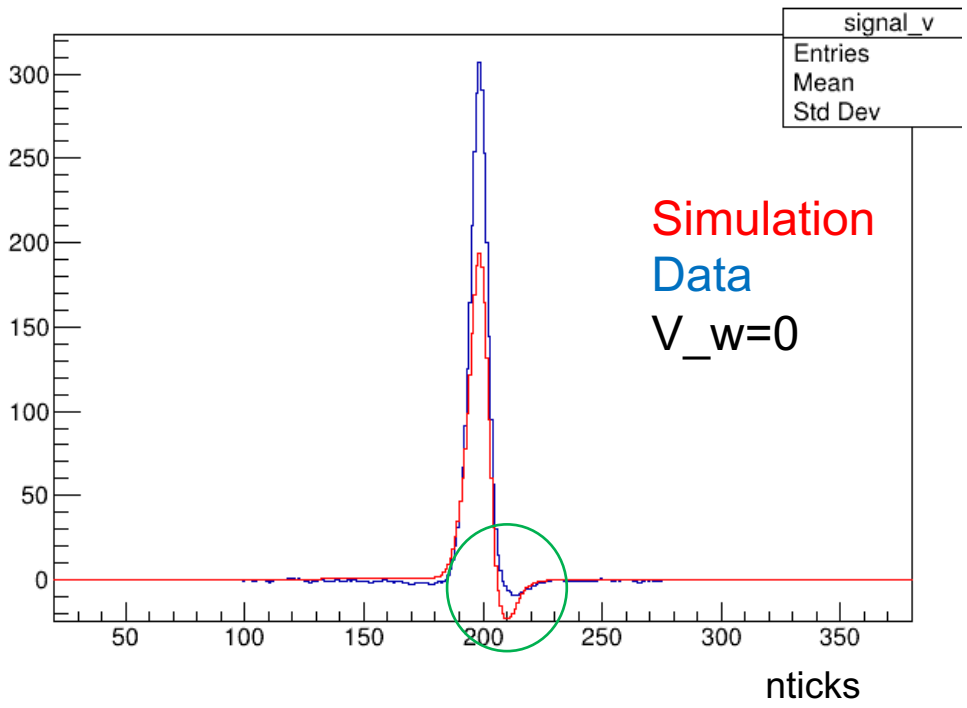


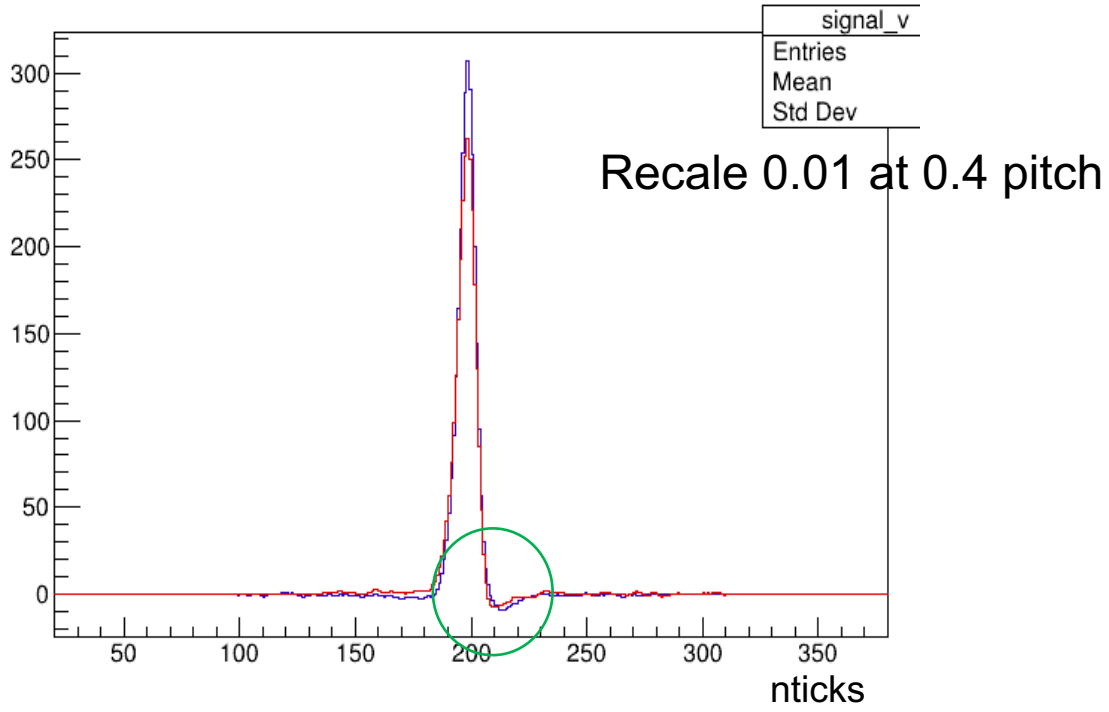






Another thing on V plane



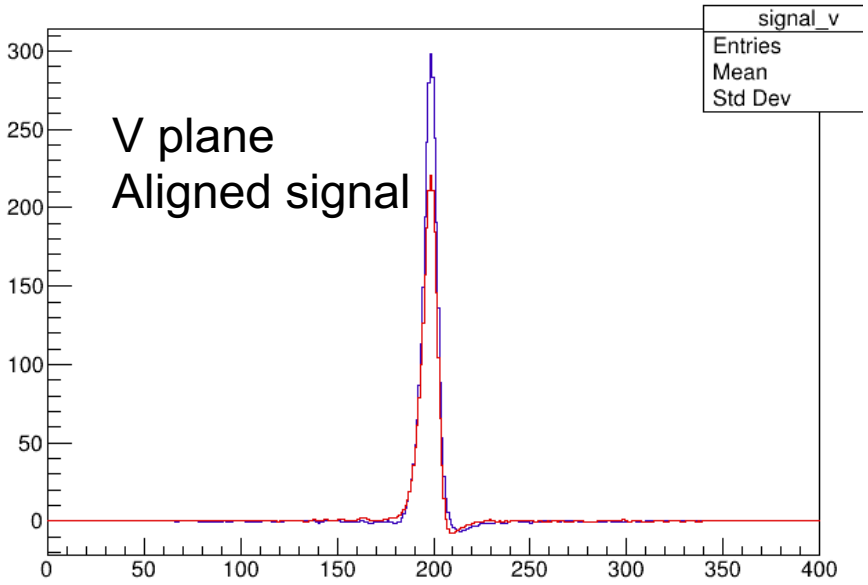


- Collection on w plane will affect signal shape on v plane

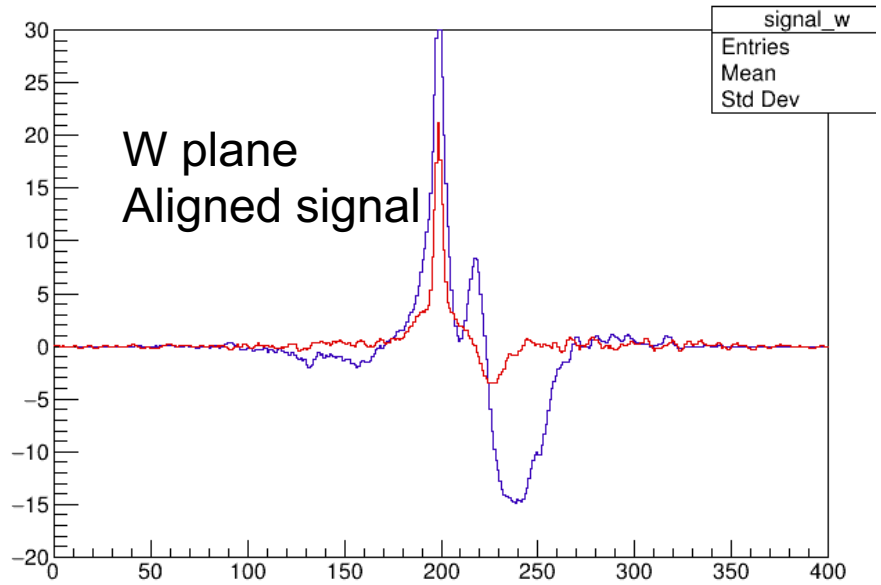
Next

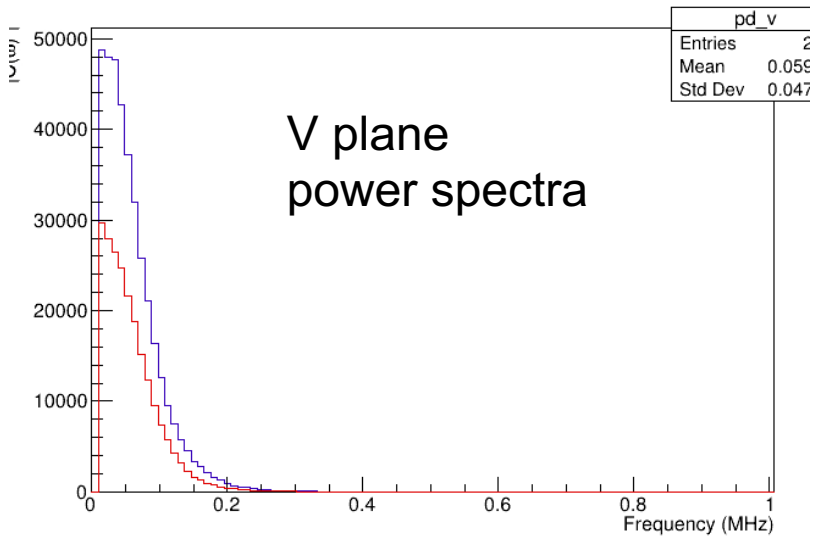
- Other direction, not consistence at the same time
- Do we need a fit on this?
- Try to include average on different wire layout?

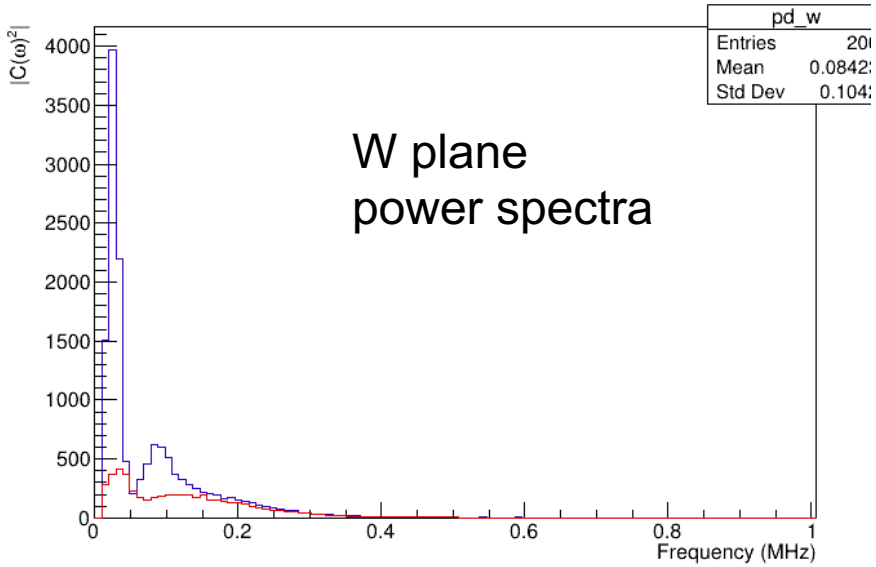
Backup: For cosmic direction



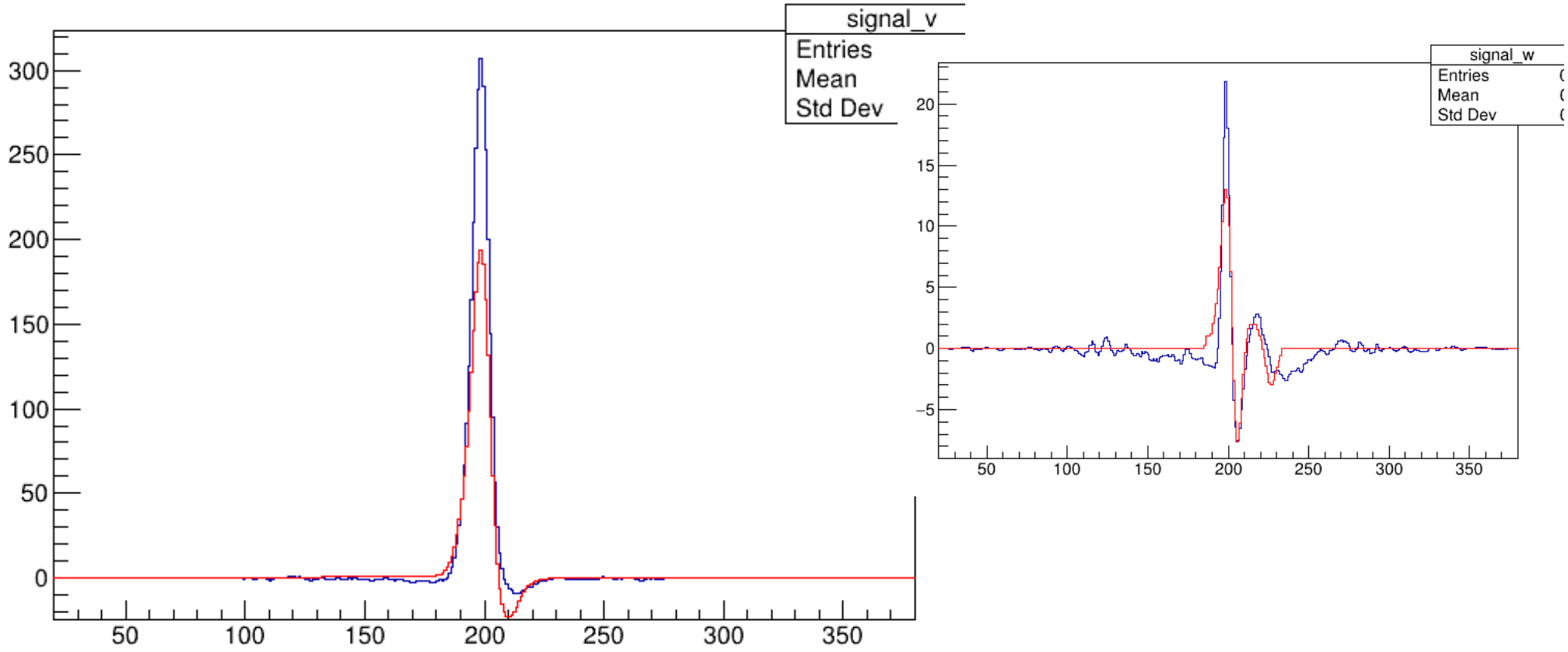
Simulation
Data



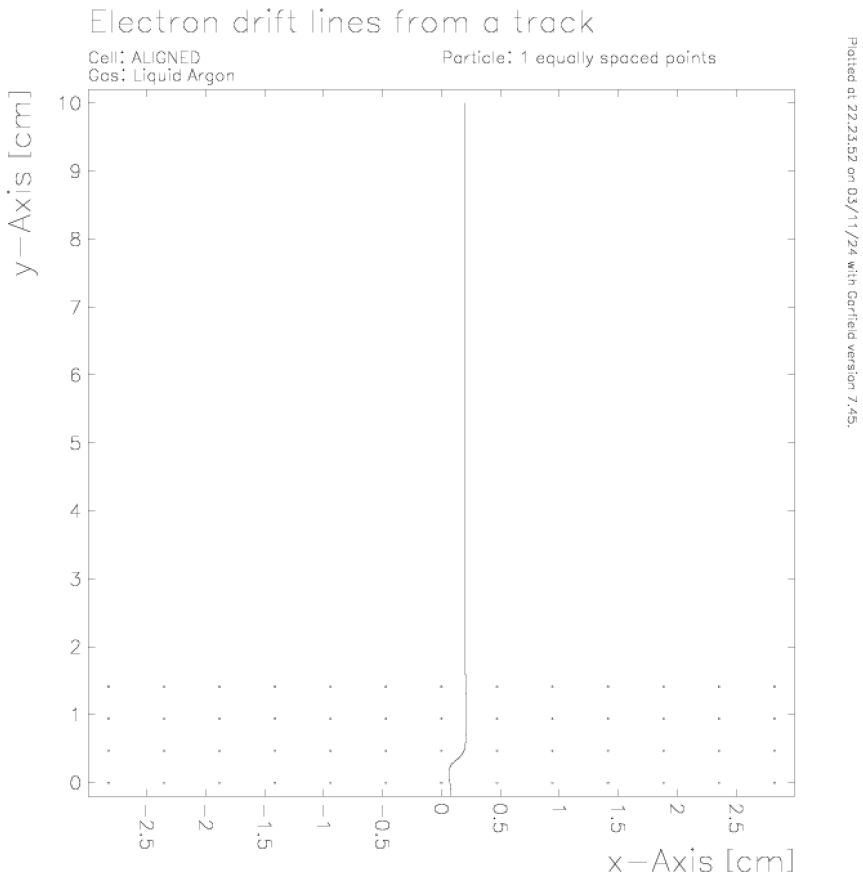


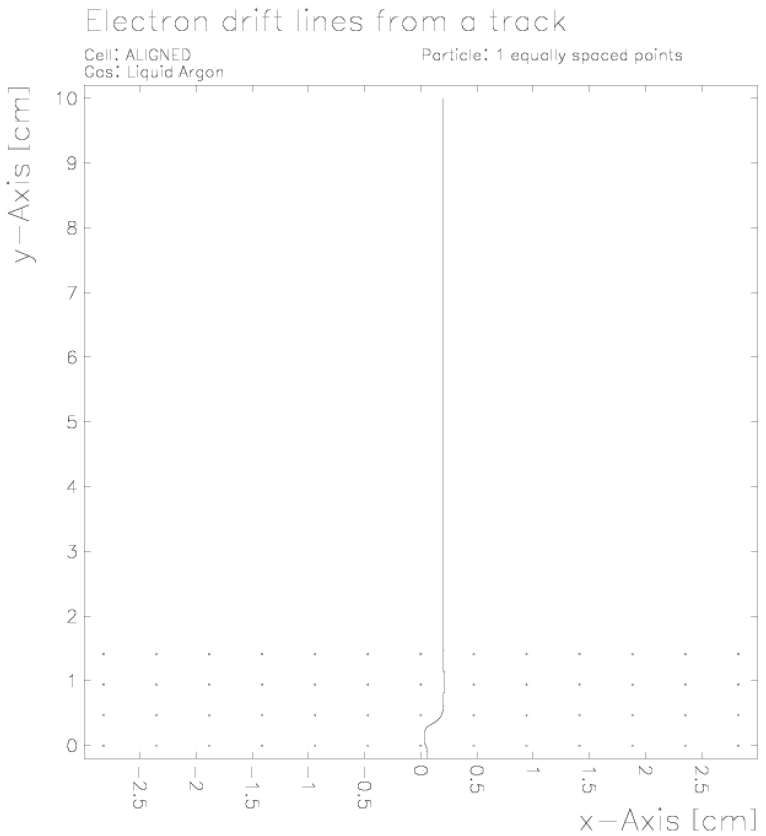


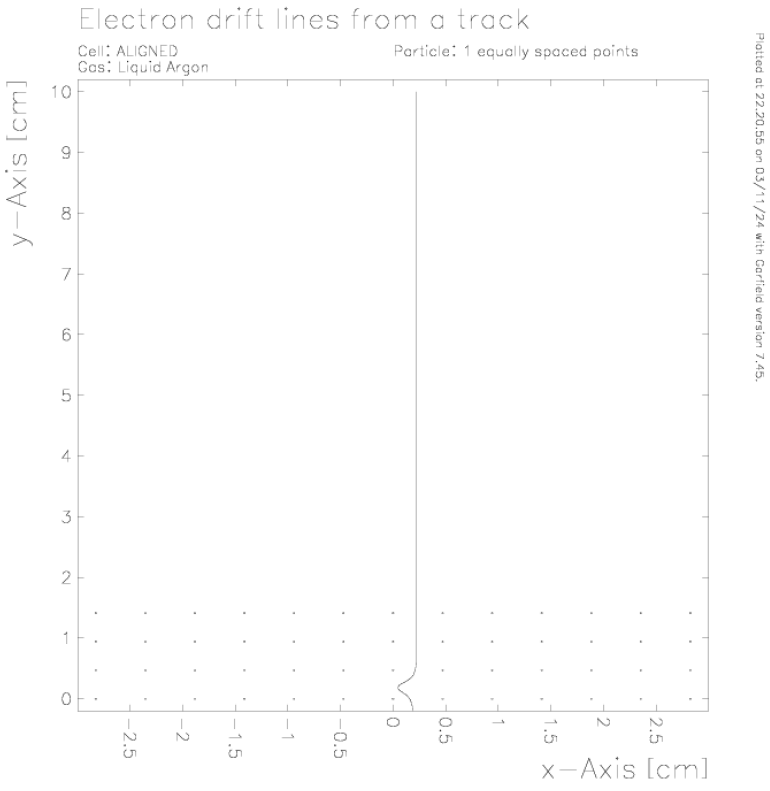
Backup

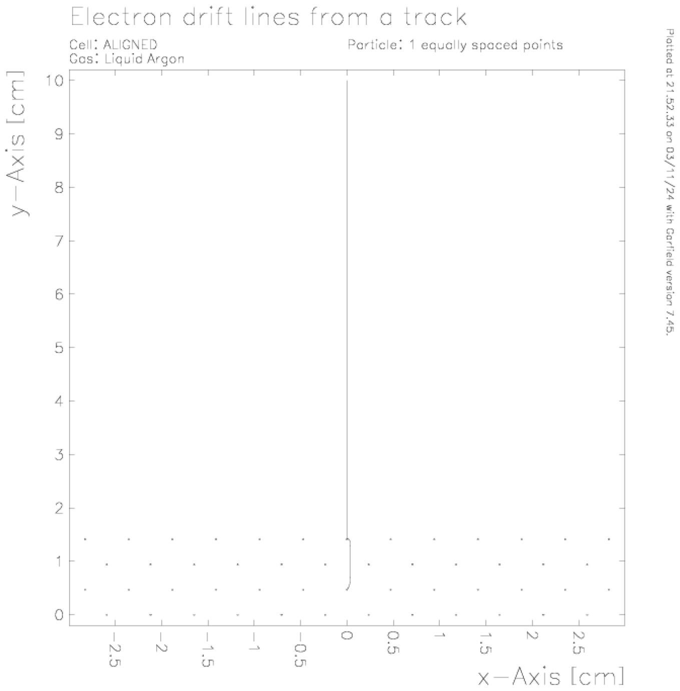

signal_v
Entries
Mean
Std Dev
300
250
200
150
100
50
0
50
100
150
200
250
300
350
signal_w
Entries
Mean
Std Dev
20
15
10
5
0
−5
50
100
150
200
250
300
350

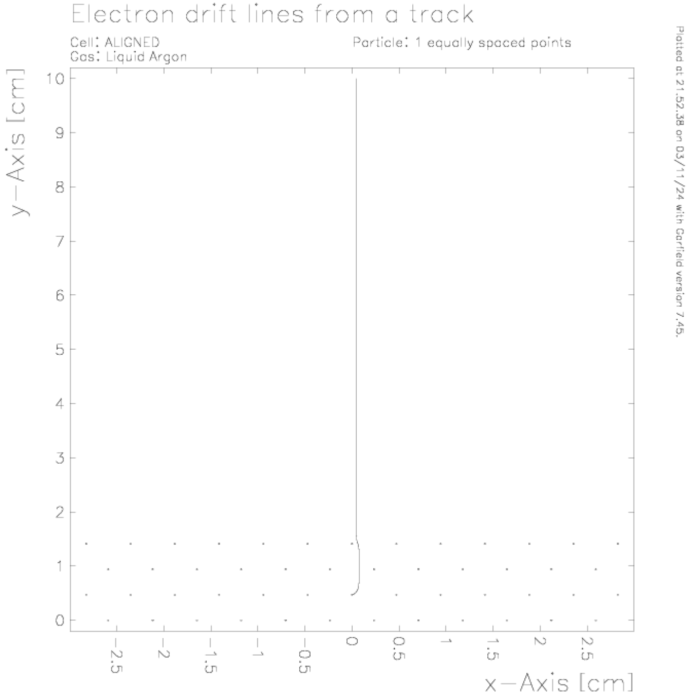
Backup

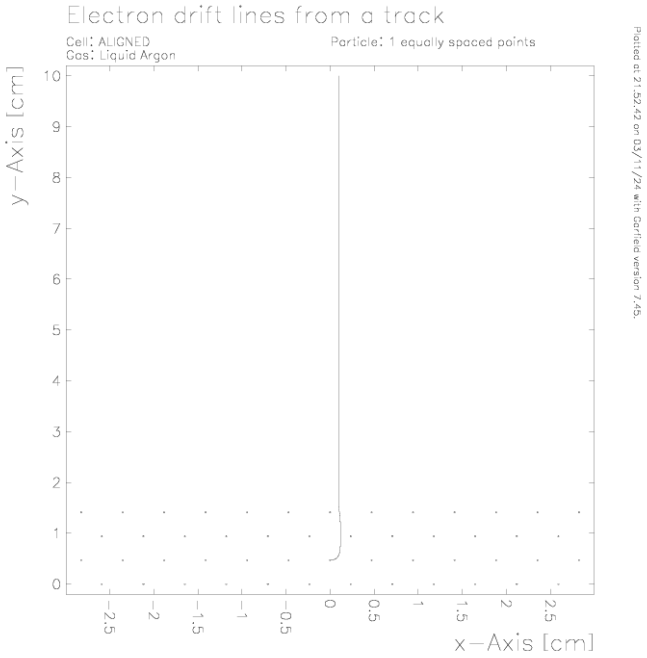

Electron drift lines from a track
Cell: ALIGNED
Gas: Liquid Argon
Particle: 1 equally spaced points
y−Axis [cm]
x−Axis [cm]
Plotted at 22:23:52 on 03/11/24 with Garfield version 7.45.

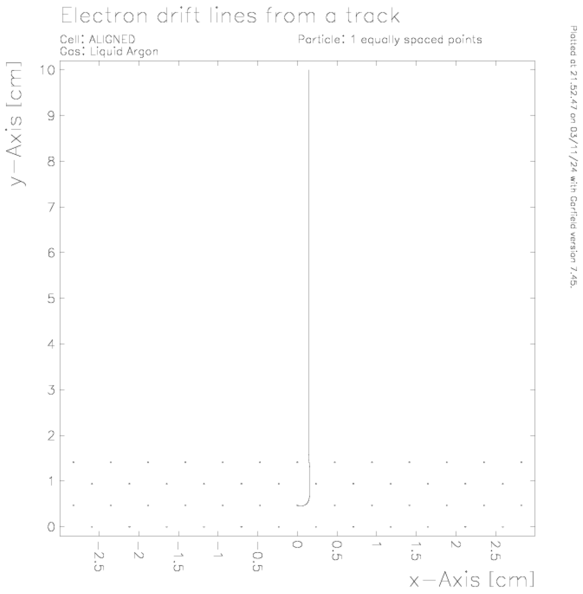

Electron drift lines from a track
Cell: ALIGNED
Gas: Liquid Argon
Particle: 1 equally spaced points
y−Axis [cm]
x−Axis [cm]

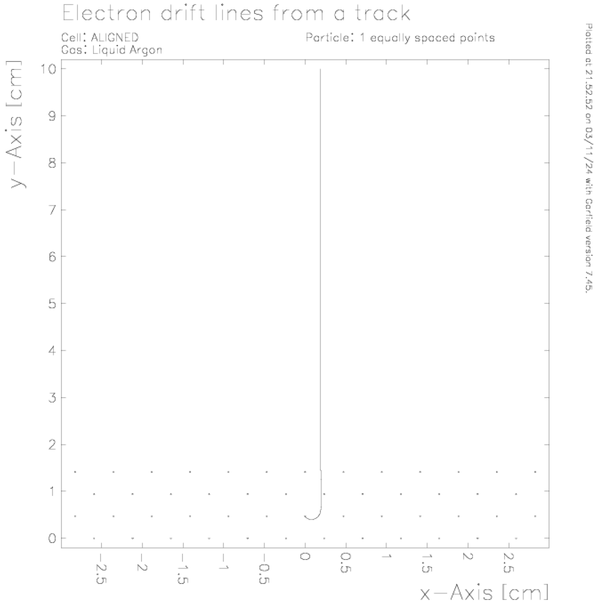

Electron drift lines from a track
Cell: ALIGNED
Gas: Liquid Argon
Particle: 1 equally spaced points
y−Axis [cm]
x−Axis [cm]
Plotted at 22:20:55 on 03/11/24 with Garfield version 7.45.

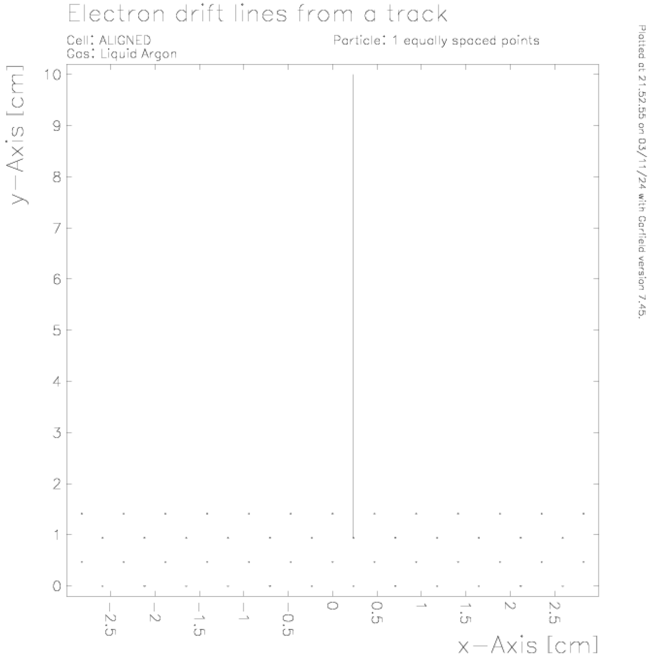

Electron drift lines from a track
Cell: ALIGNED
Gas: Liquid Argon
Particle: 1 equally spaced points
y−Axis [cm]
x−Axis [cm]
Plotted at 21.52.33 on 03/11/24 with Garfield version 7.45.


Electron drift lines from a track
Cell: ALIGNED
Gas: Liquid Argon
Particle: 1 equally spaced points
y−Axis [cm]
x−Axis [cm]
Plotted at 21.52.38 on 03/11/24 with Garfield version 7.45.

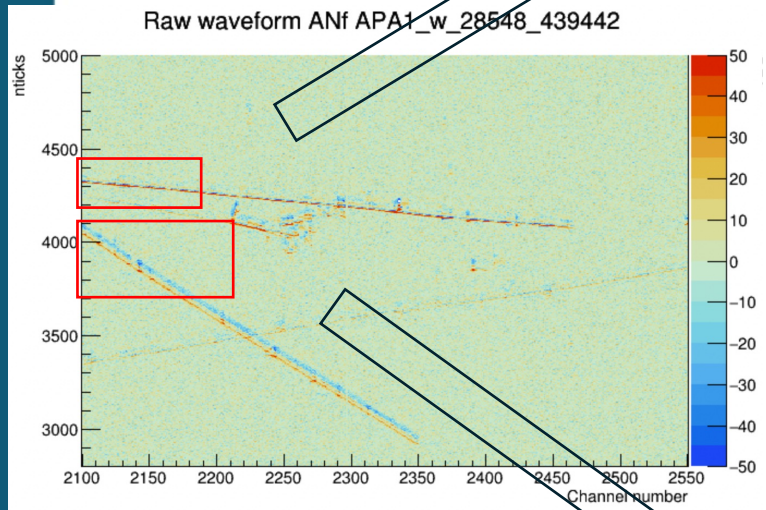

Electron drift lines from a track
Cell: ALIGNED
Gas: Liquid Argon
Particle: 1 equally spaced points
y−Axis [cm]
x−Axis [cm]
Plotted at 21.52.42 on 03/11/24 with Garfield version 7.45.


Electron drift lines from a track
Cell: ALIGNED
Gas: Liquid Argon
Particle: 1 equally spaced points
y−Axis [cm]
x−Axis [cm]
Plotted at 21.52.47 on 03/11/24 with Garfield version 7.45.

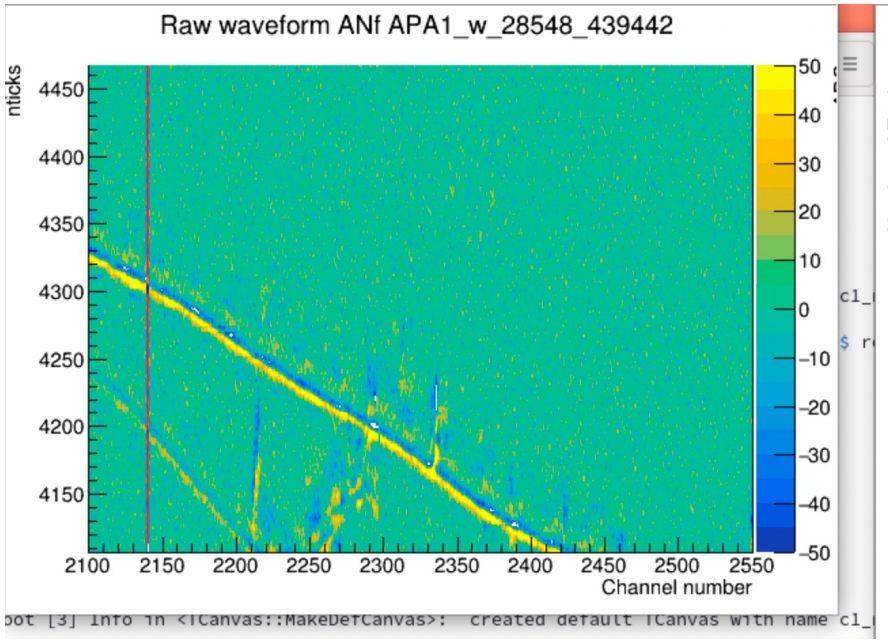

Electron drift lines from a track
Cell: ALIGNED
Gas: Liquid Argon
Particle: 1 equally spaced points
y−Axis [cm]
x−Axis [cm]
Plotted at 21.52.52 on 03/11/24 with Garfield version 7.45.

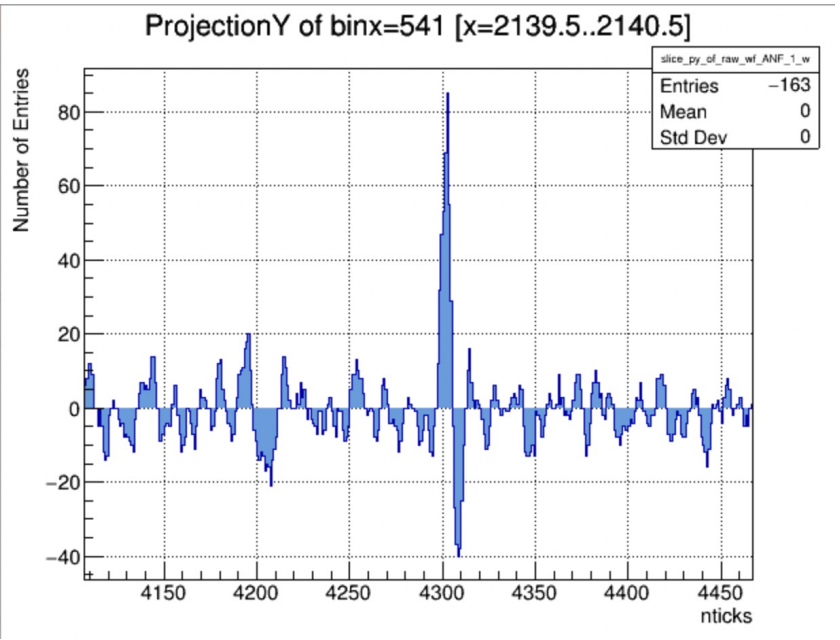

Electron drift lines from a track
Cell: ALIGNED
Gas: Liquid Argon
Particle: 1 equally spaced points
y−Axis [cm]
x−Axis [cm]
Plotted at 21.52.55 on 03/11/24 with Garfield version 7.45.

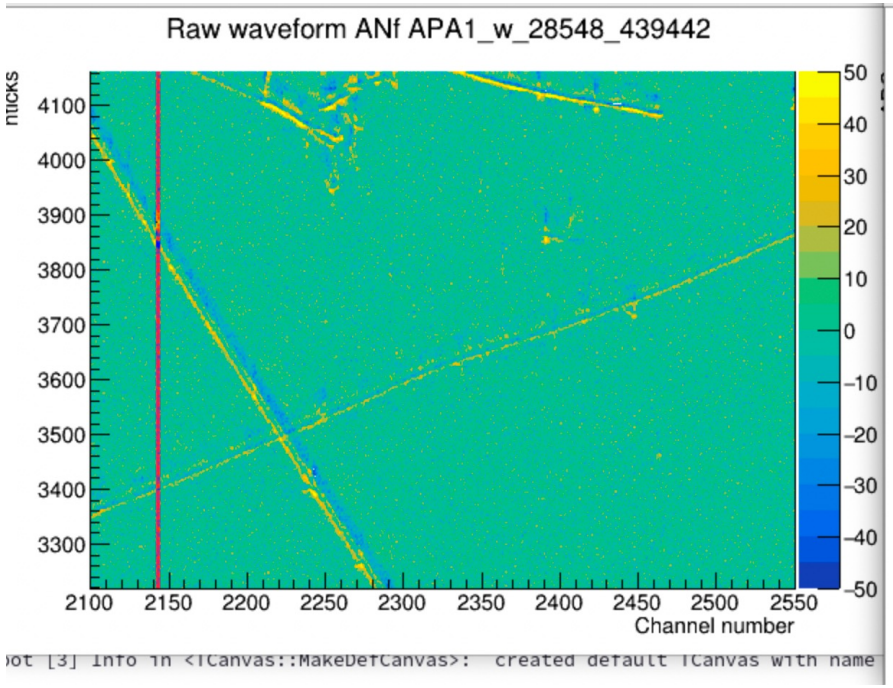
Zoom in

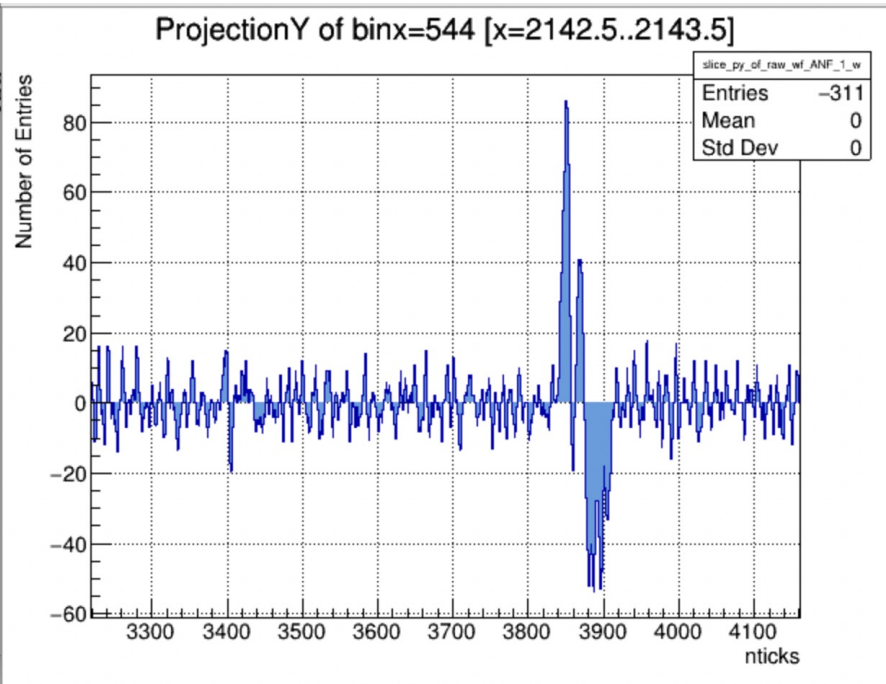


Zoom in









Brookhaven National Laboratory