Geometry sorter & channel map schemes for VD

FD Sim/Reco, 01.03.21

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Intro

- For geometry interpretation need to provide methods for sorting various GeoXXX objects

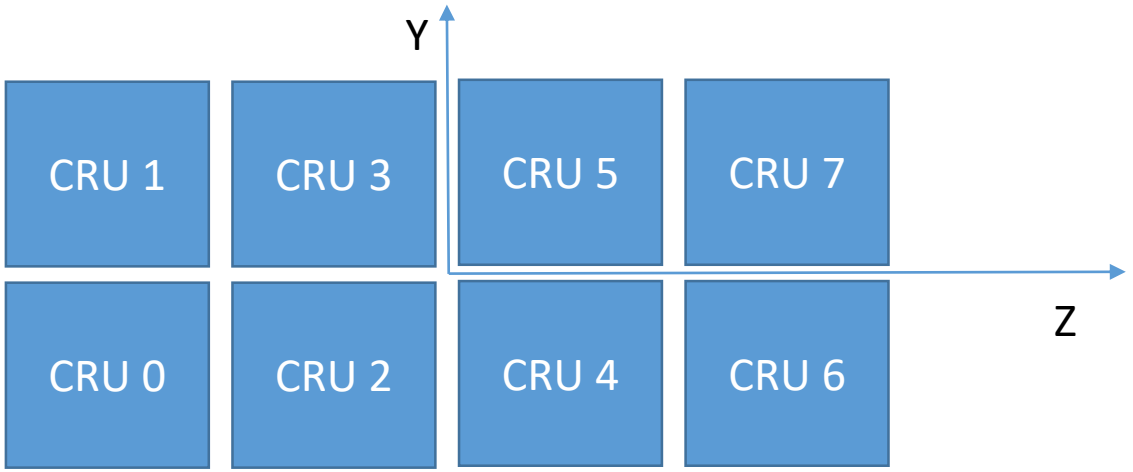
ChannelMapCRUAlg
GeoObjectSorterCRU

Assumptions for drift directions hardcoded! (X-drift)

In ChannelMapAlg for VD is included in DUNEGeometryHelper_service.cc

```
// DUNE 10kt vd
} else if ( detectorName.find("dunevd10kt") != std::string::npos ) {
  channelMap = std::make_unique<geo::ChannelMapCRUAlg>(pset);
```

Geo objects sorting : CRUs (“TPCs” & Planes)



CRUs

- Sort in same Z group
- Sort in increasing Y

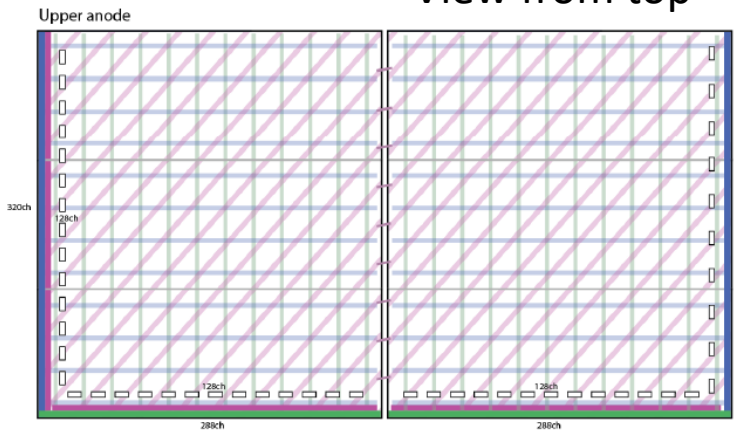
Readout planes: along the drift direction (0 inner most → 2 outer most for 3-view layout)

Geo objects sorting : wires

- All wires are sorted increasing Z first
- For same Z:
  1. Horizontal wires $\theta_Z = 0$
     - Wires are sorted in increasing Y
  2. Angular wires $\theta_Z \neq 0$
     - $\theta_Z > 90°$ sorted in increasing Y
     - $\theta_Z < 90°$ sorted in decreasing Y

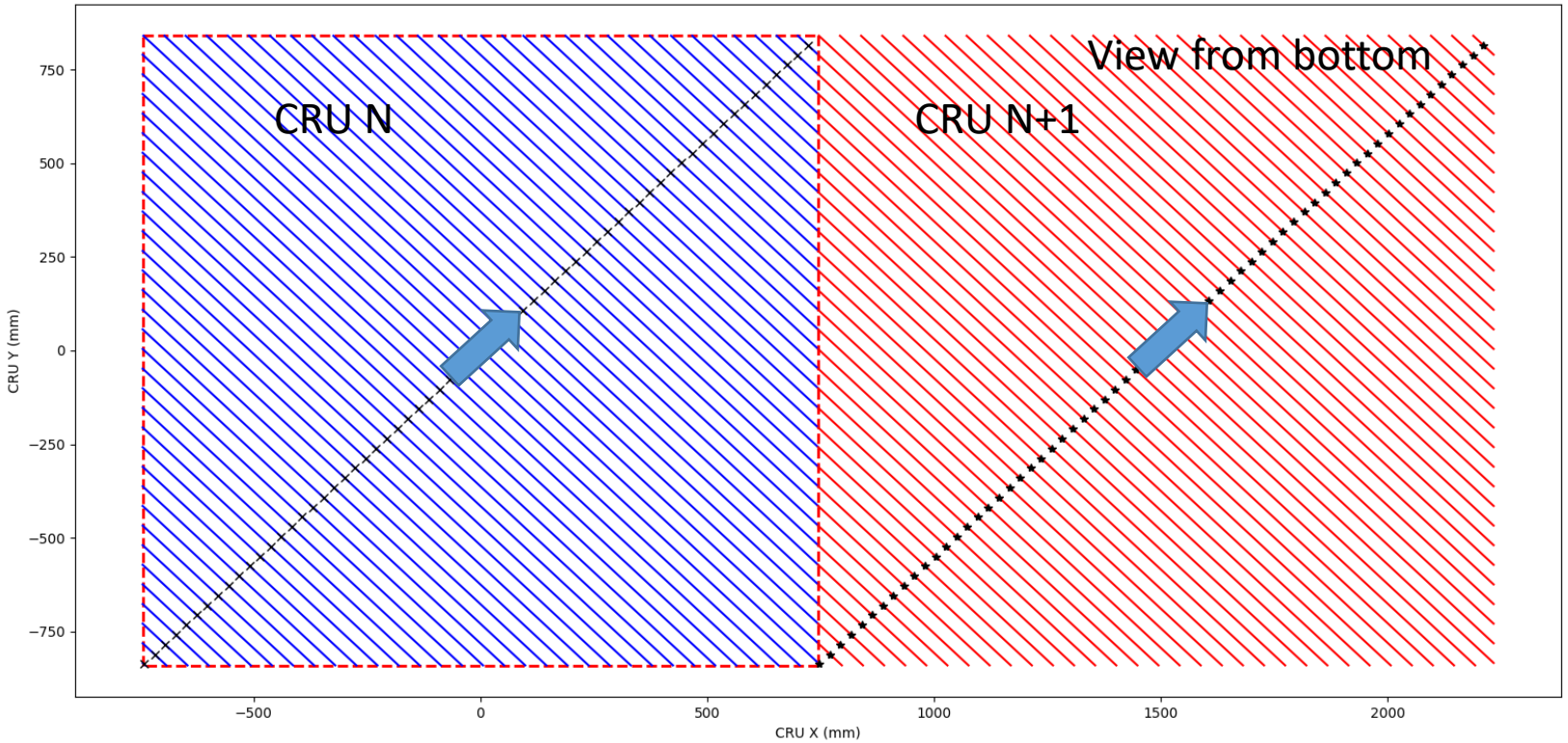
Wire sorting :
3 – view proposal

View from top



-48 deg induction view

-ve z → +ve z

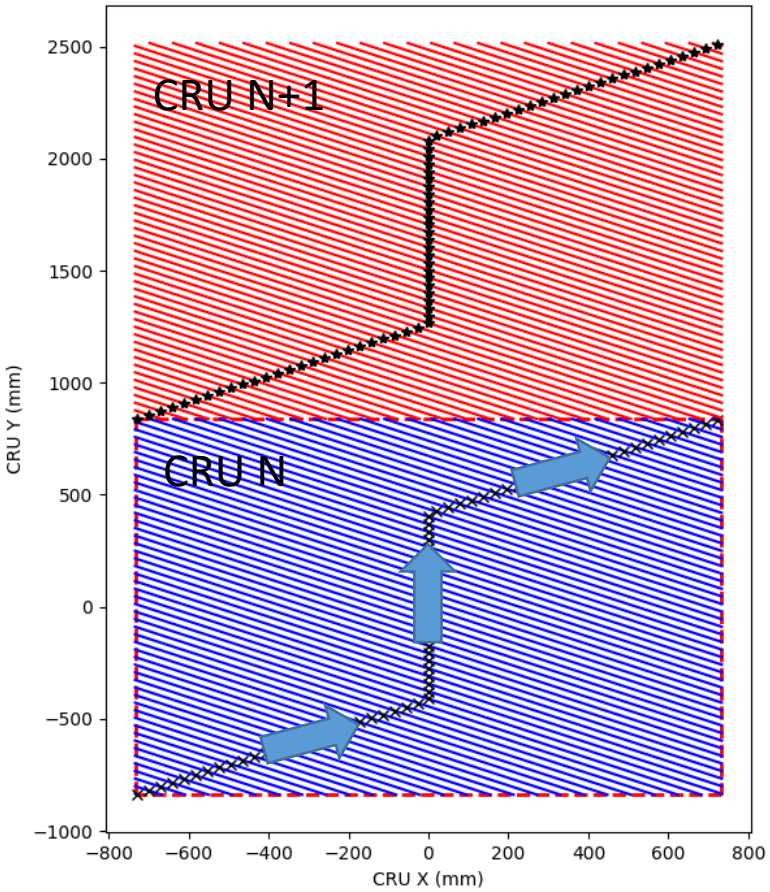


Z

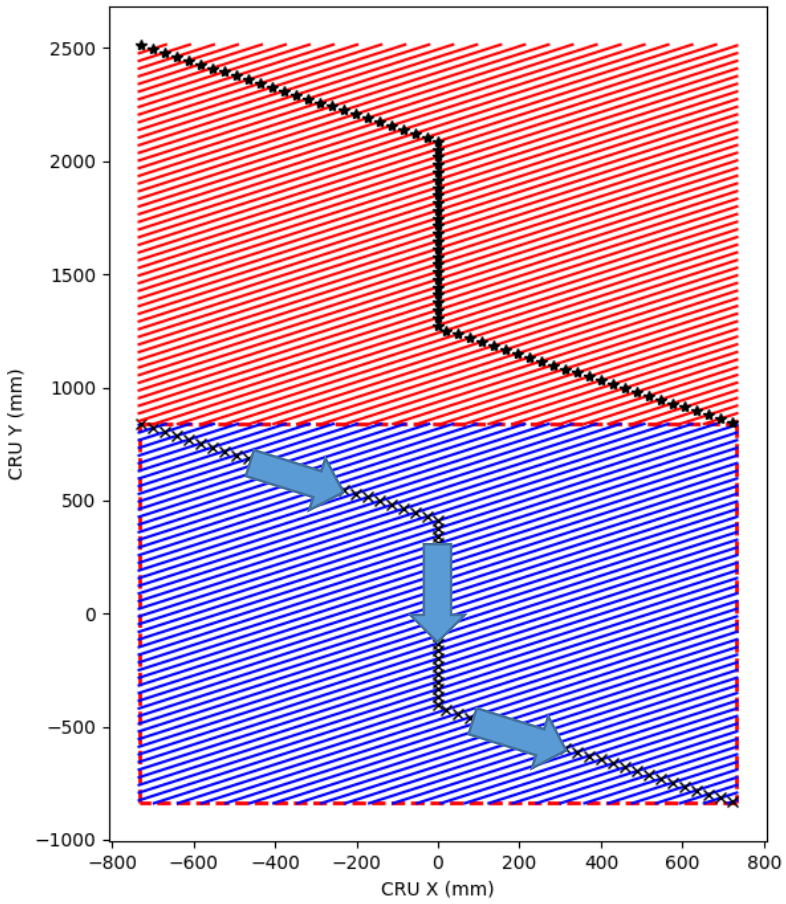
Wire sorting : 30 deg layout

View from bottom

Induction1 -30 deg



Induction2 30 deg



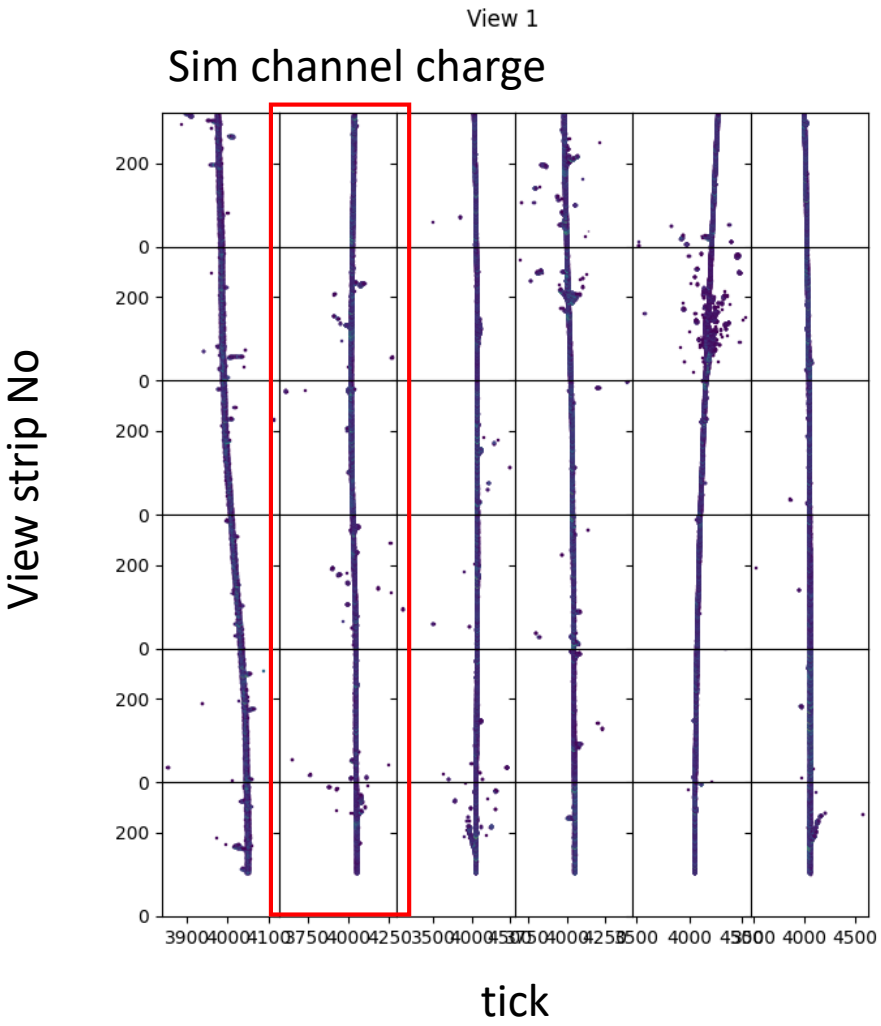
Z

Angle of horizontal wires

- Last time mentioned there was an issue with sorting wires +30 view
- Needed to add some minor fixes to the sorting algorithm by checking also the strip angle wrt Z (ThetaZ)
- Fixed the problem with +/- 30 deg, but then ran into for sorting horizontal wires
- After some time managed to trace the problem to the wire angle ThetaZ being NaN for some CRUs caused by a rounding errors in $\theta_z = \cos^{-1} x$ (Issue #25559)
- Went back to check the gdml for 3-view and indeed there were 6 CRUs that had this issue with wire angle

Horizontal view check

3-view proposal: induction view with thetaZ = 0



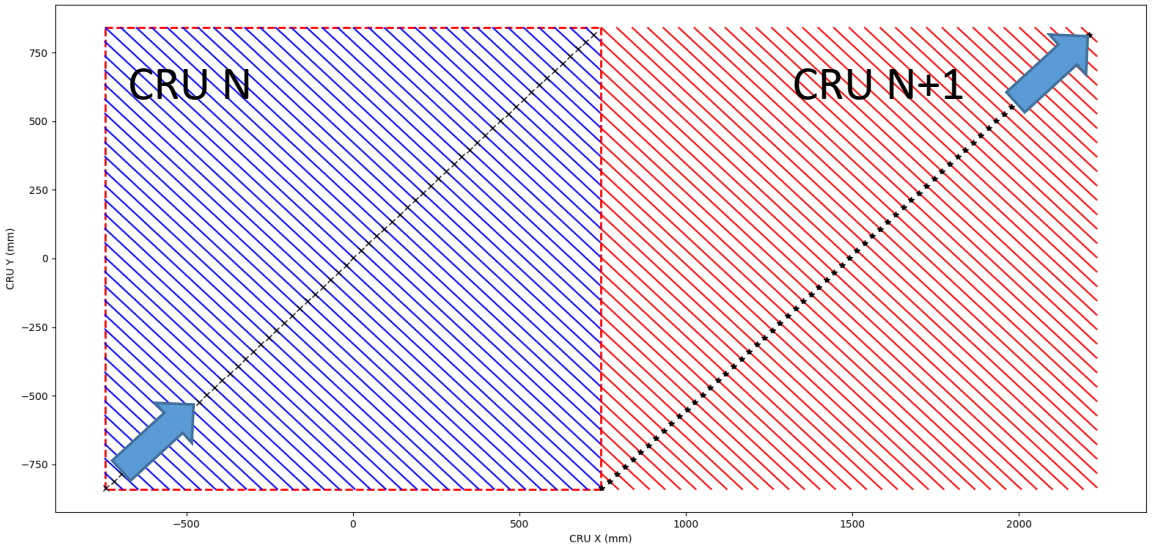
The mapping to SimChannel in SimDriftElectrons appears still to have worked

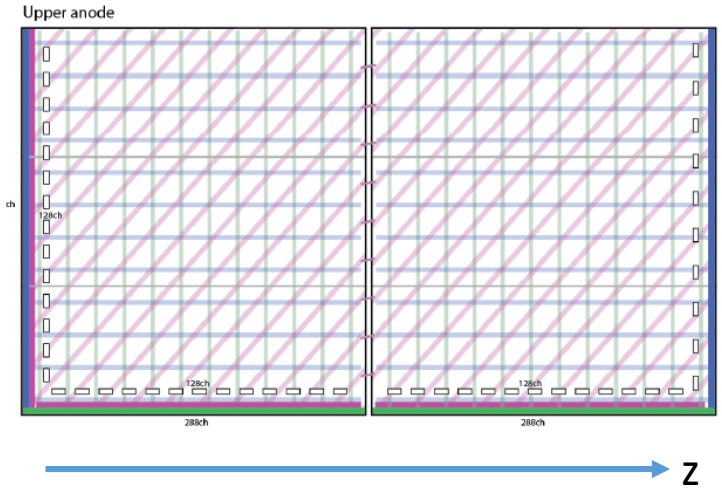
Mapping wires to channels

- The default map is one-to-one
- For 3-view layouts the views with strips at the angle are bridged between anode boards
- Need to map two wires to one readout channel

- Different schemes are possible
- I will show one option which perhaps could be the easiest

Wire –to – channel map :
3 – view proposal





Induction 1: -48 deg

- CRU N [0, 127] → CH [0, 127]
- Crossing strips → CH [128, 255]
  - CRU N 128 → CRU N+1 0
  - CRU N 255 → CRU N+1 127
- CRU N+1 [128, 255] → CH[256, 383]

Induction 2: 0 deg

- CRU N [0, 319] → CH [384, 703]
- CRU N+1 [0, 319] → CH [704, 1023]

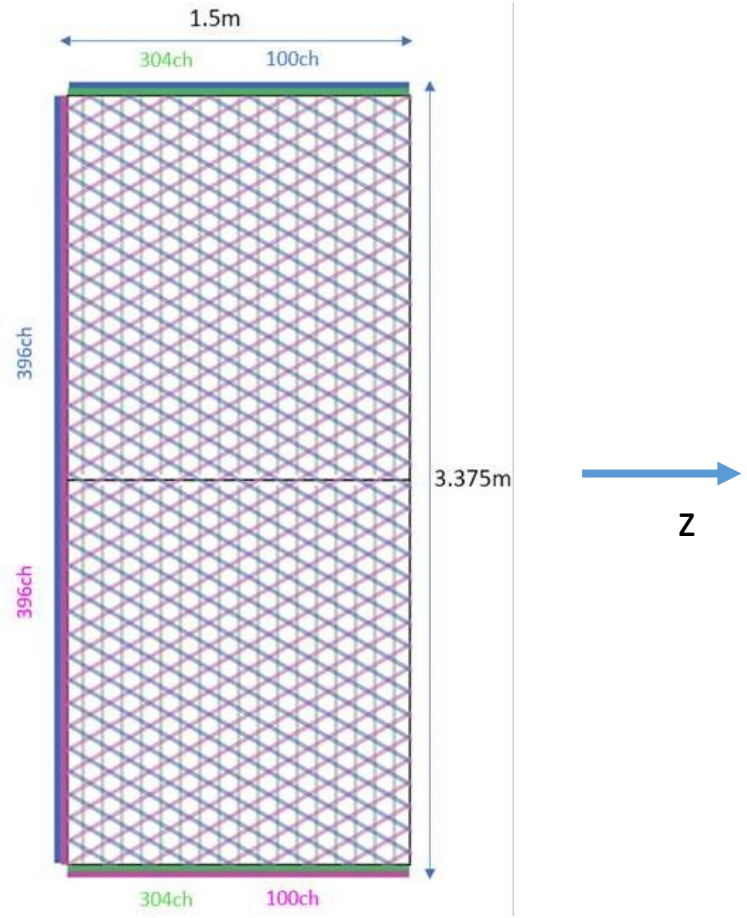
Collection: 90 deg

- CRU N [0, 287] → CH [1024, 1311]
- CRU N+1 [0, 287] → CH [1312, 1599]

→ 3200 channels per CRP (4 x CRUs)

Wire – to – channel map : 30 deg

- Induction 1 : 496 ch
- Induction 2 : 496 ch
- Collection : 2 x 304 ch



Wire – to – channel map : 30 deg

Induction1 : -30 deg → 496 ch

- CRU N [0, 197] → CH [0, 197]
- Crossing strips → CH [198, 297]
  - CRU N 198 → CRU N+1 0
  - …
  - CRU N 297 → CRU N+1 99
- CRU N+1 [100, 297] → CH [298, 495]

✓ 496 readout channels

Induction1 : +30 deg → 496 ch

- CRU N+1 [0, 197] → CH [0, 197]
- Crossing strips → CH [198, 297]
  - CRU N+1 198 → CRU N 0
  - …
  - CRU N+1 297 → CRU N 99
- CRU N [100, 297] → → CH [298, 495]

✓ 496 readout channels

Collection:

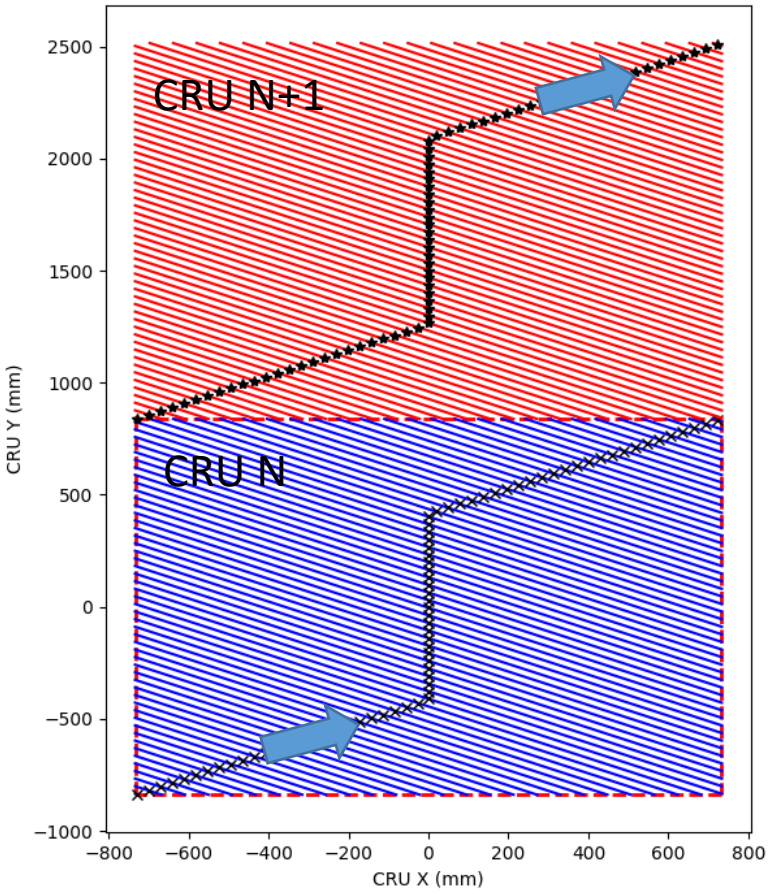
- CRU N [0, 303] → CH [992, 1295]
- CRU N+1 [0, 303] → CH [1296, 1599]

➔ 3200 channels per CRP (4 x CRUs)

Channel mapping : 30 deg layout

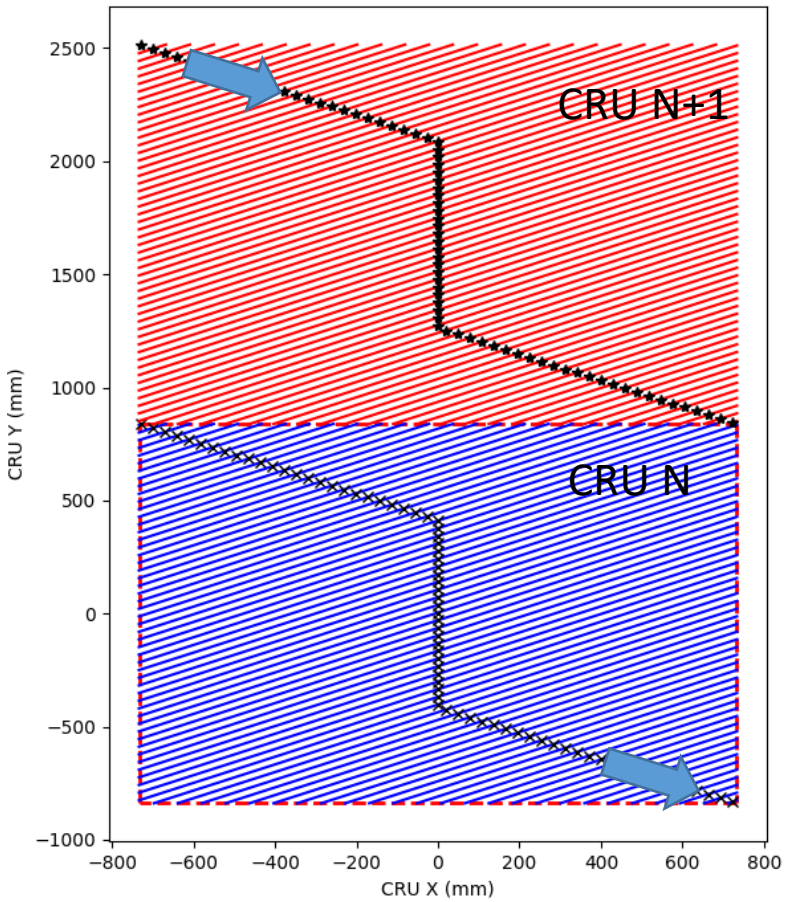
View from bottom

Induction1 -30 deg



Arrows Ch 0 → 495

Induction2 30 deg

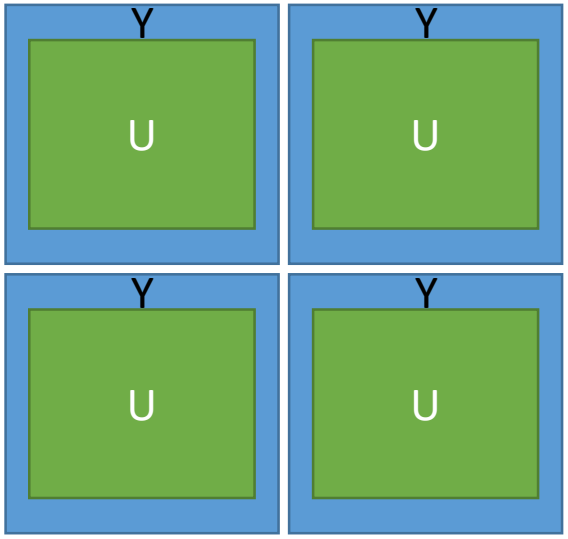


Arrows Ch 0 → 495

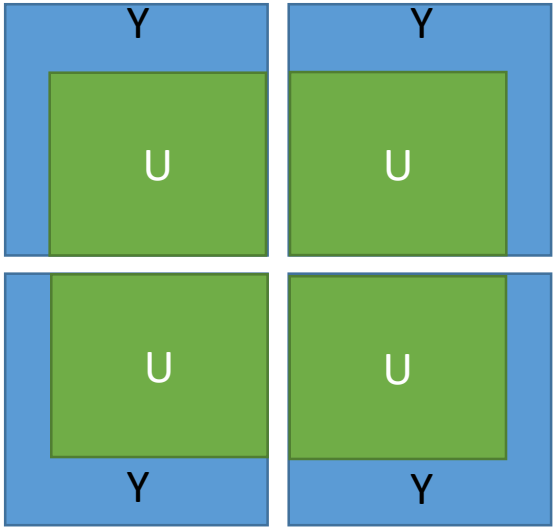
Strip alignment

- The angular views define the active area given a number of strips, pitch, and angle
- This area may not be exactly the same as the area of vertical/horizontal views
- Some discontinuity in-between strips in neighboring CRUs
  - Can minimize this for the side which is bridged, but not on all sides

Currently all the readout planes have the same center



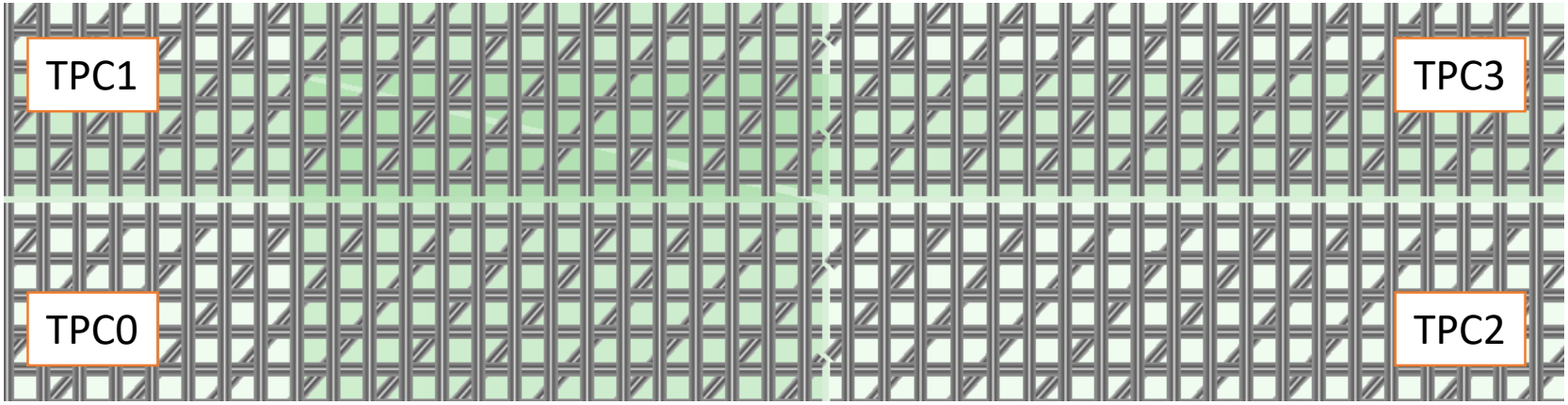
For angular strips to be aligned at CRP level need to offset U/V planes

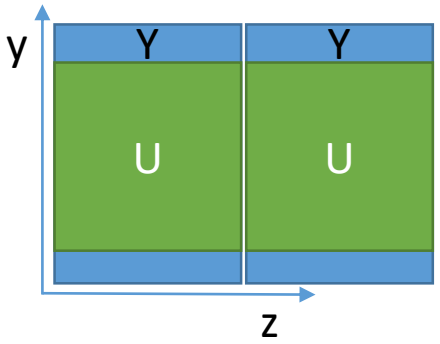


Displacing planes is not too difficult, but building readout volume would require 4 pieces put together correctly (instead of one)
Not sure if there are any assumptions on ROP centering later on

Strip alignment

Example: 3-view proposal, a zoom on the center of CRP (4 CRUs)





U-plane dimensions are the same in Z : strips align at between CRUs

But U plane is slightly narrower in Y when subsequent Y or Z planes : some discontinuity

Conclusions

- The sorting scheme for VD Geo objects is hopeful fixed now
  - Makes assumptions on the drift axis being X (so to be revisited later on)

- For horizontal view, there was an issue caused by float rounding with ThetaZ calculation in geo::WireGeo constructor : going through larsoft pull request / approval process
  - Didn't look like this affecting charge to channel assignment

- In the process of implementing the wire-to-channel mapping for U/V type induction views
  - Simple one-to-one map : 2 – view readout
  - Map for 3-view proposal : some U wires have to be mapped to single channel
  - Map for 3-view 30 deg : some U & V wires need to be mapped to a single channel