



# Tagging APA Crossing Cosmic Rays in Pandora

Steven Green on behalf of the Pandora Team

28th November 2018

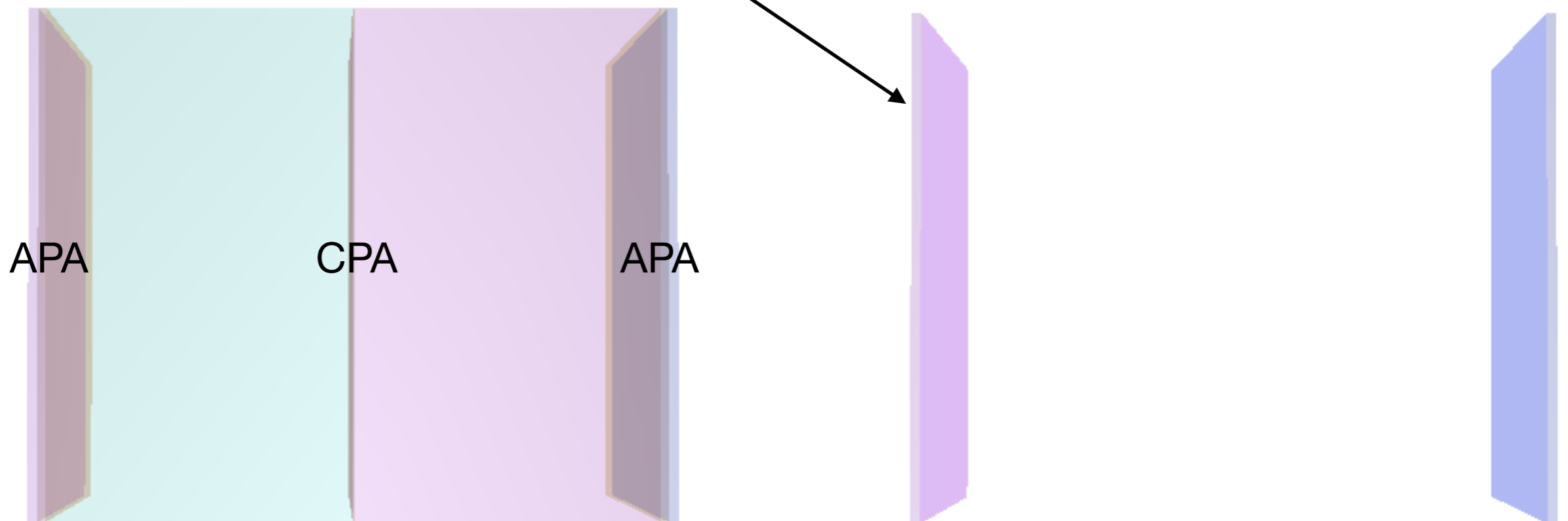


Aim:

- Determine if Pandora can use hits produced in the cryostat side of the APAs to stitch (tag) cosmic rays crossing the APA boundary.



- First step is to make sure Pandora is reading in the cryostat side APA hits.
- For details on code setup to produced these hits c.f. [Leigh's talk](#) from last weeks meeting.
  - Since then Leigh has also made a feature branch of dunetpc with these changes in feature/lhw\_cryohits
- The Pandora geometry model groups together TPCs with the same drift volume, so in effect there are four drift volumes to consider for ProtoDUNE. The cryostat side APA hits appearing in the external drift volumes.



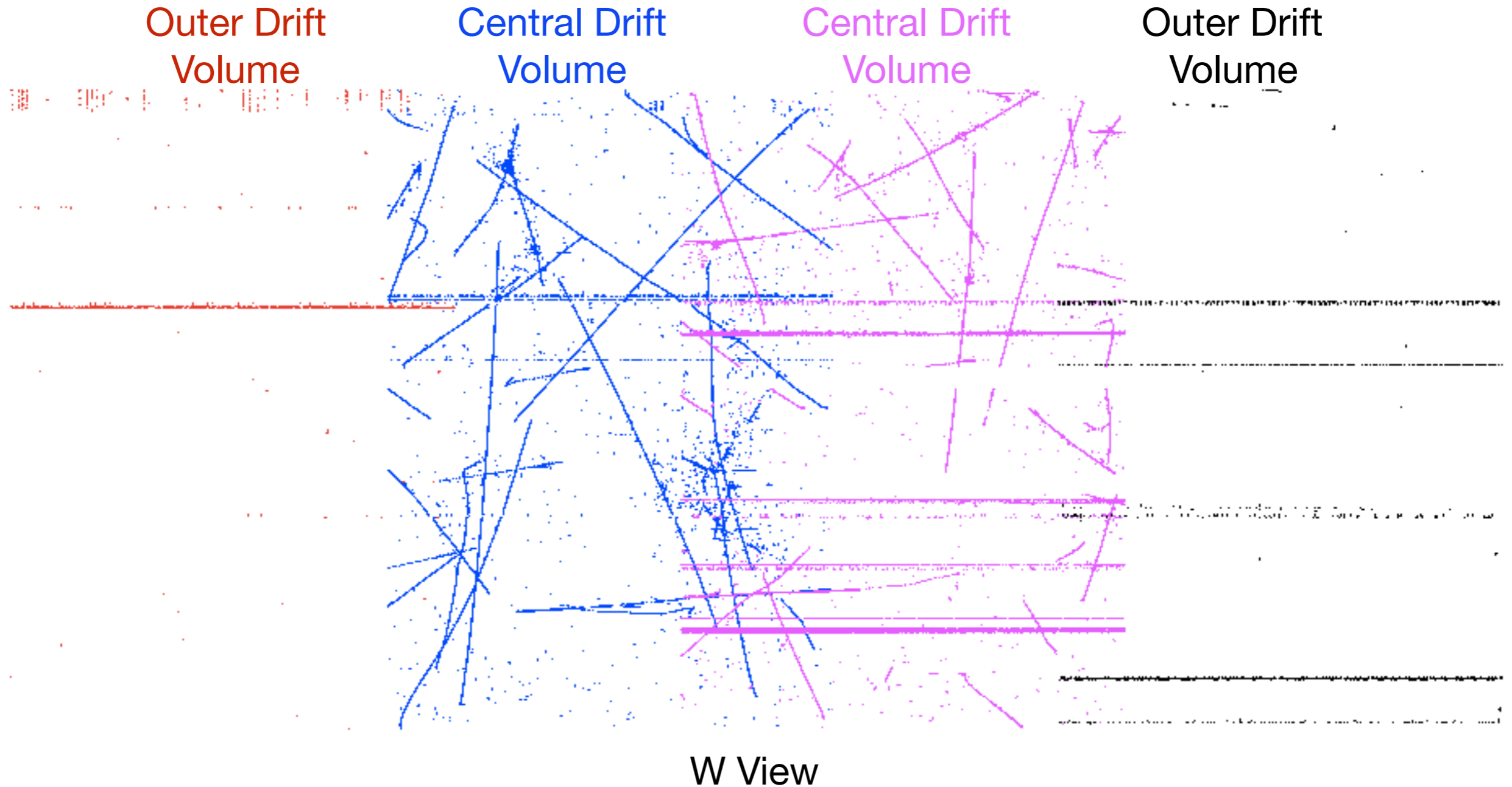
Pandora Event Display of ProtoDUNE Geometry



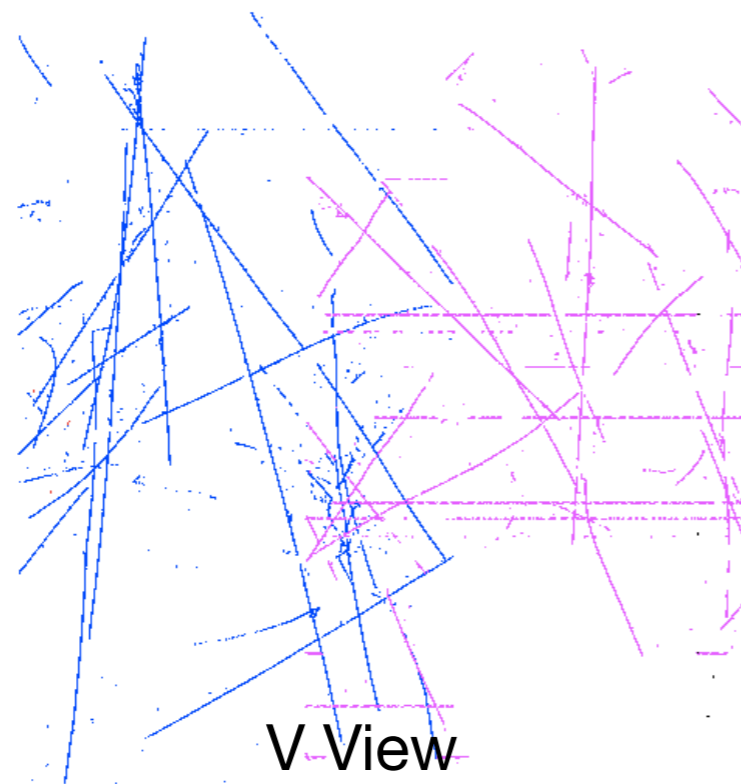
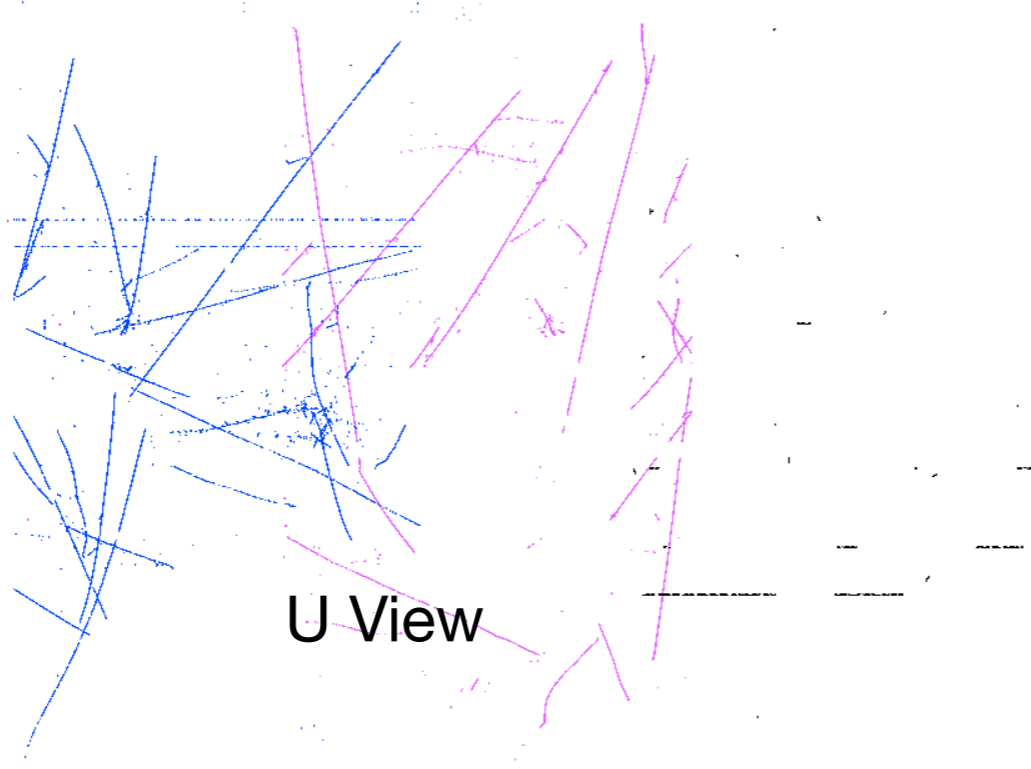
# Cryostat Side APA Hits



- To demonstrate this I colour coordinated the 2D views based on their drift volume.
- As you can see the outer drift volumes contain hits.



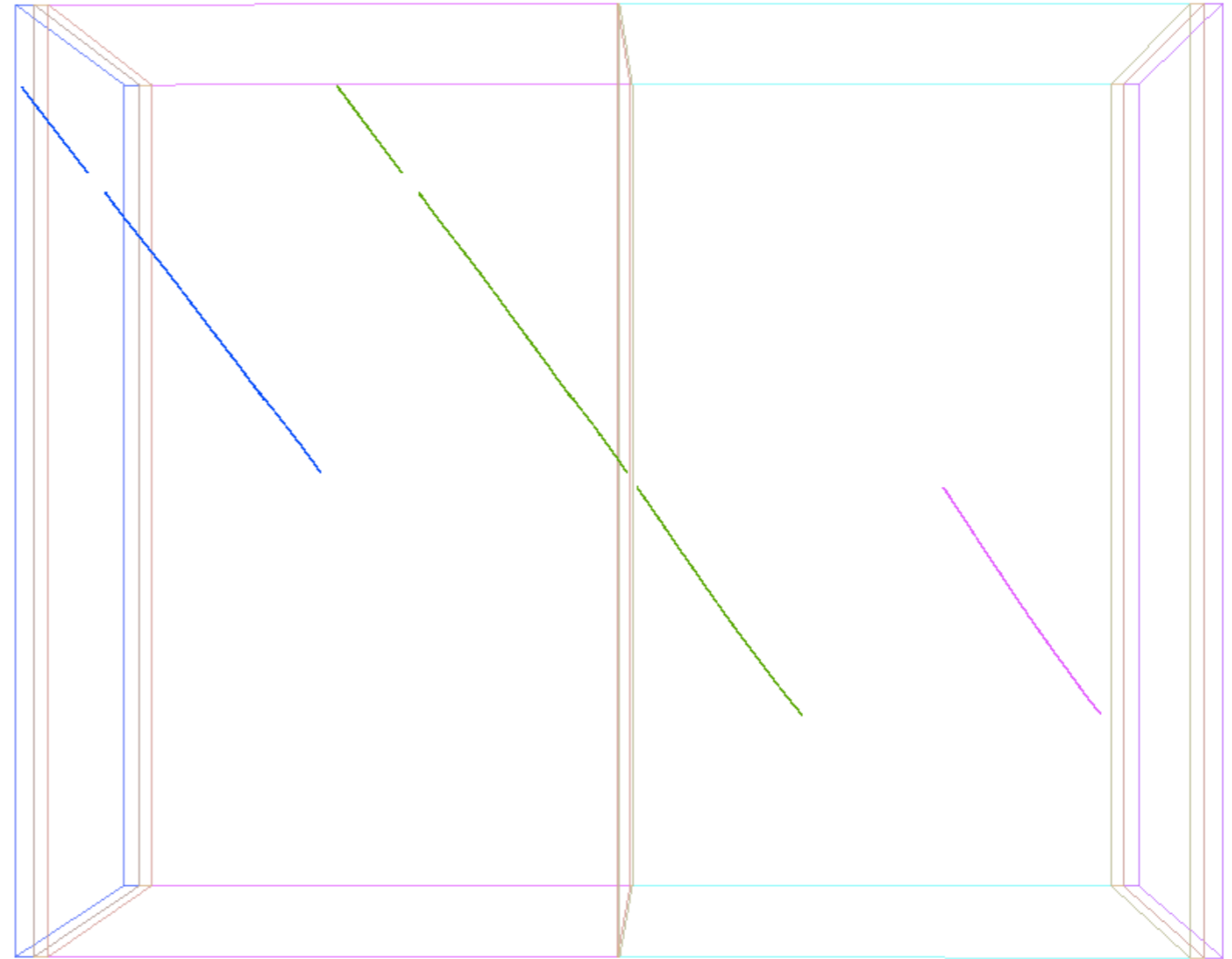
Test Event : Run 5145, Event 271909



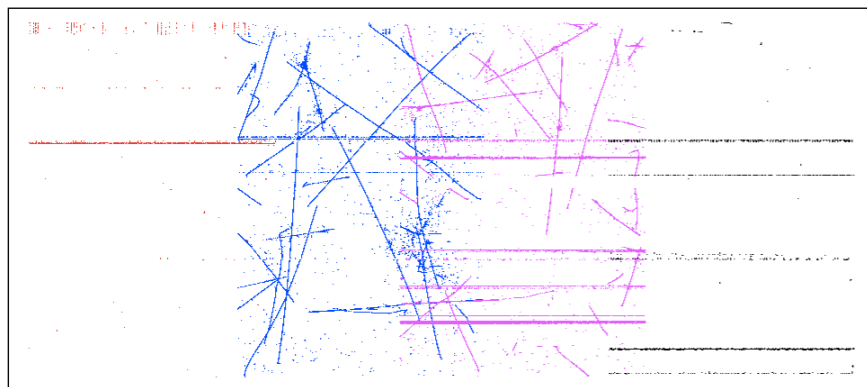
- Additional hits are also present in the U and V views.



- Brief example showing stitching working between the two central drift volumes.

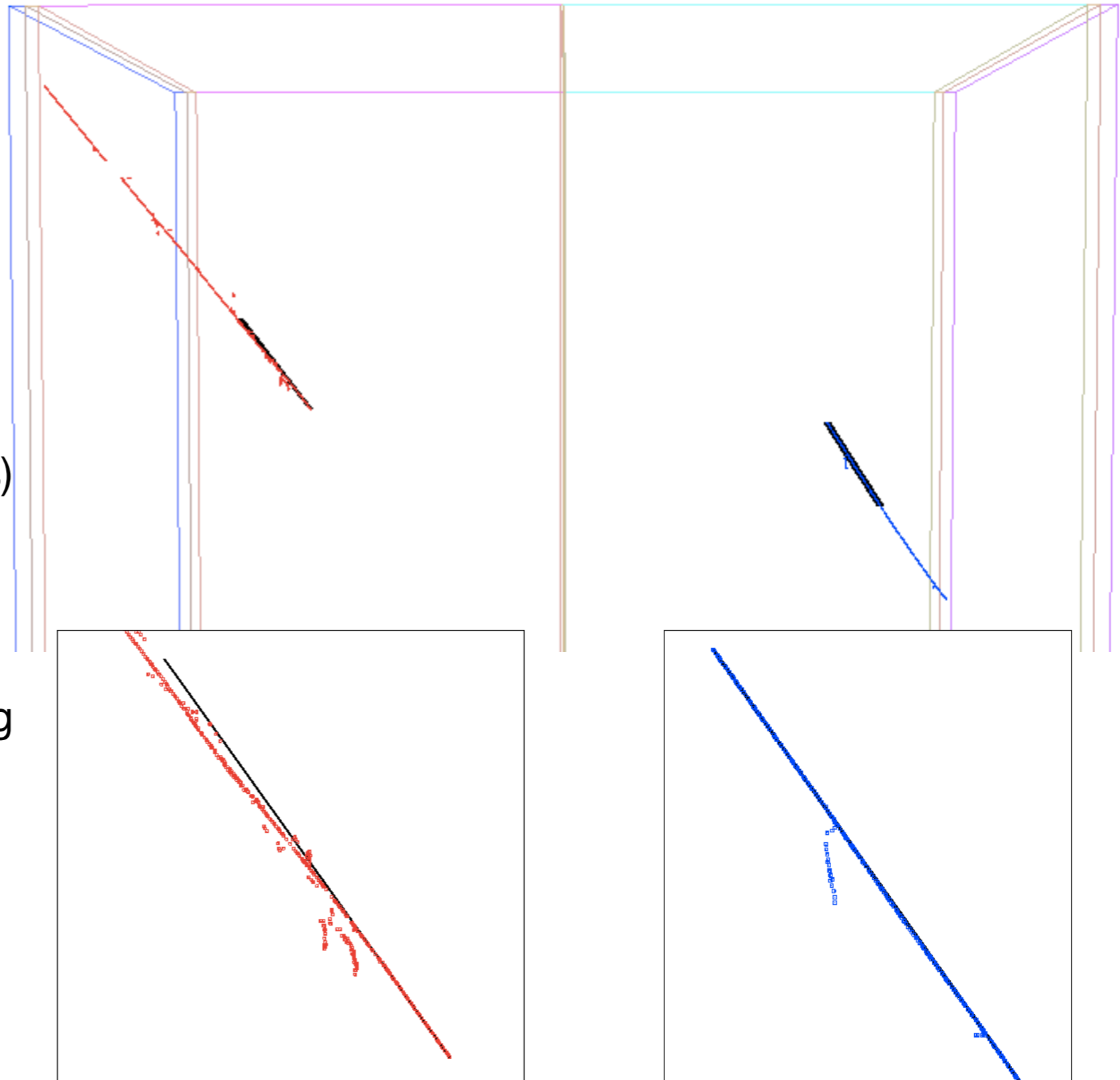


Outer Drift Volume    Central Drift Volume    Central Drift Volume    Outer Drift Volume



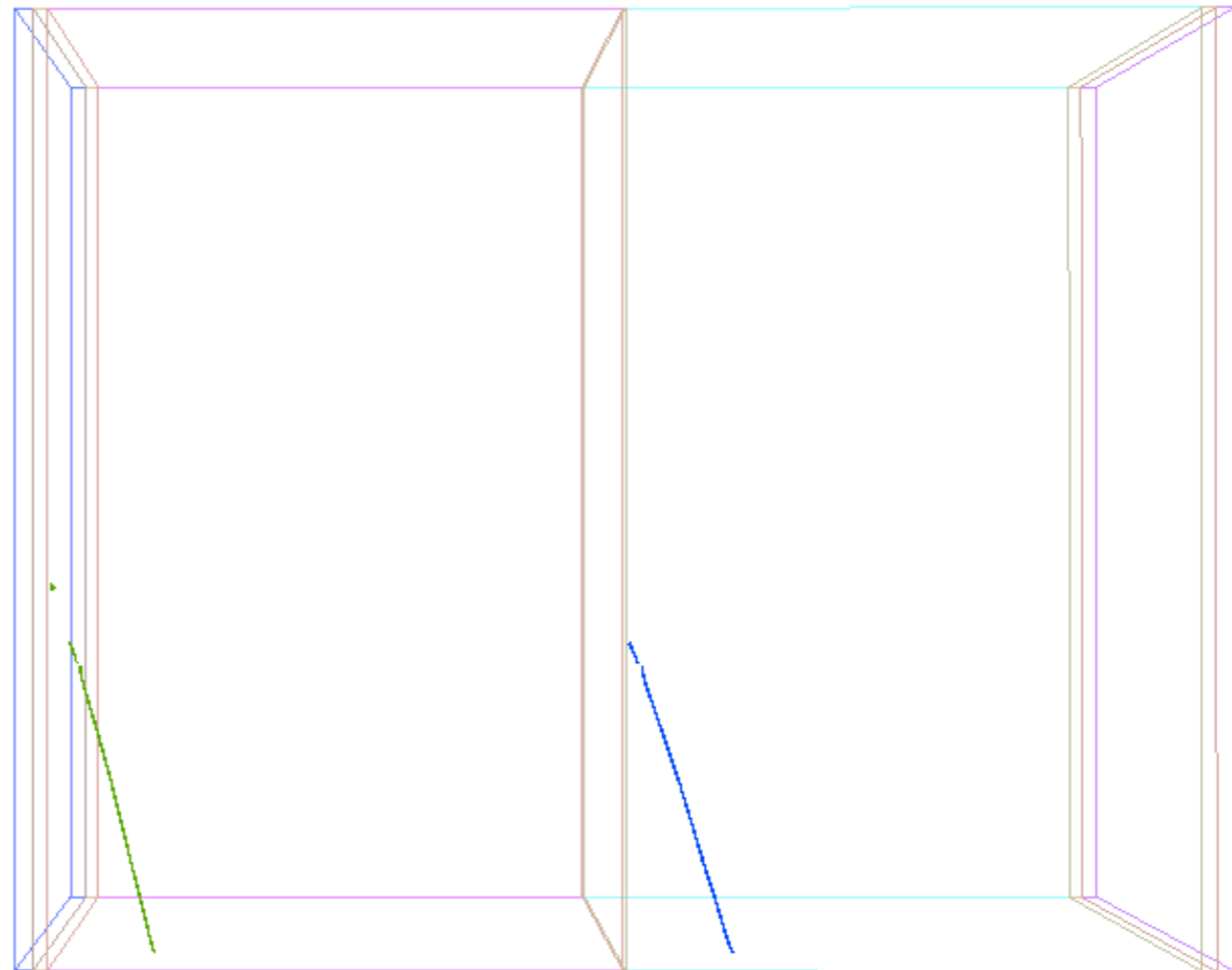


- Stitching will not work directly out of the box for these side APAs even though the code is setup to stitch adjacent drift volume particles.
- The reason is that to stitch particles Pandora applies a fit to the reconstructed particles from each drift volume (c.f. black lines) to determine whether particles point at each other.
- There is a cut on the minimum particle length to use for stitching to ensure reliability in the fit direction (default 50cm).
- Therefore, I reduced this cut to 5cm to ensure particles in the cryostat side of the APA would be considered.

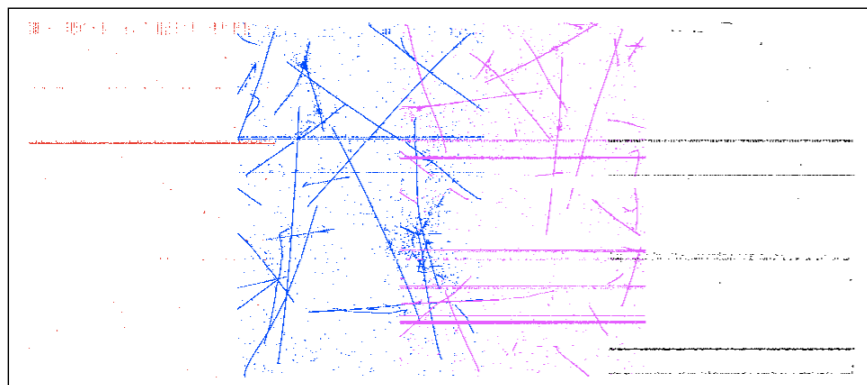




- Then stitching across the APA works (with one minor change to LArContent).
- As long as Pandora can reconstruct a 3D particle from the cryostat side APA hits.



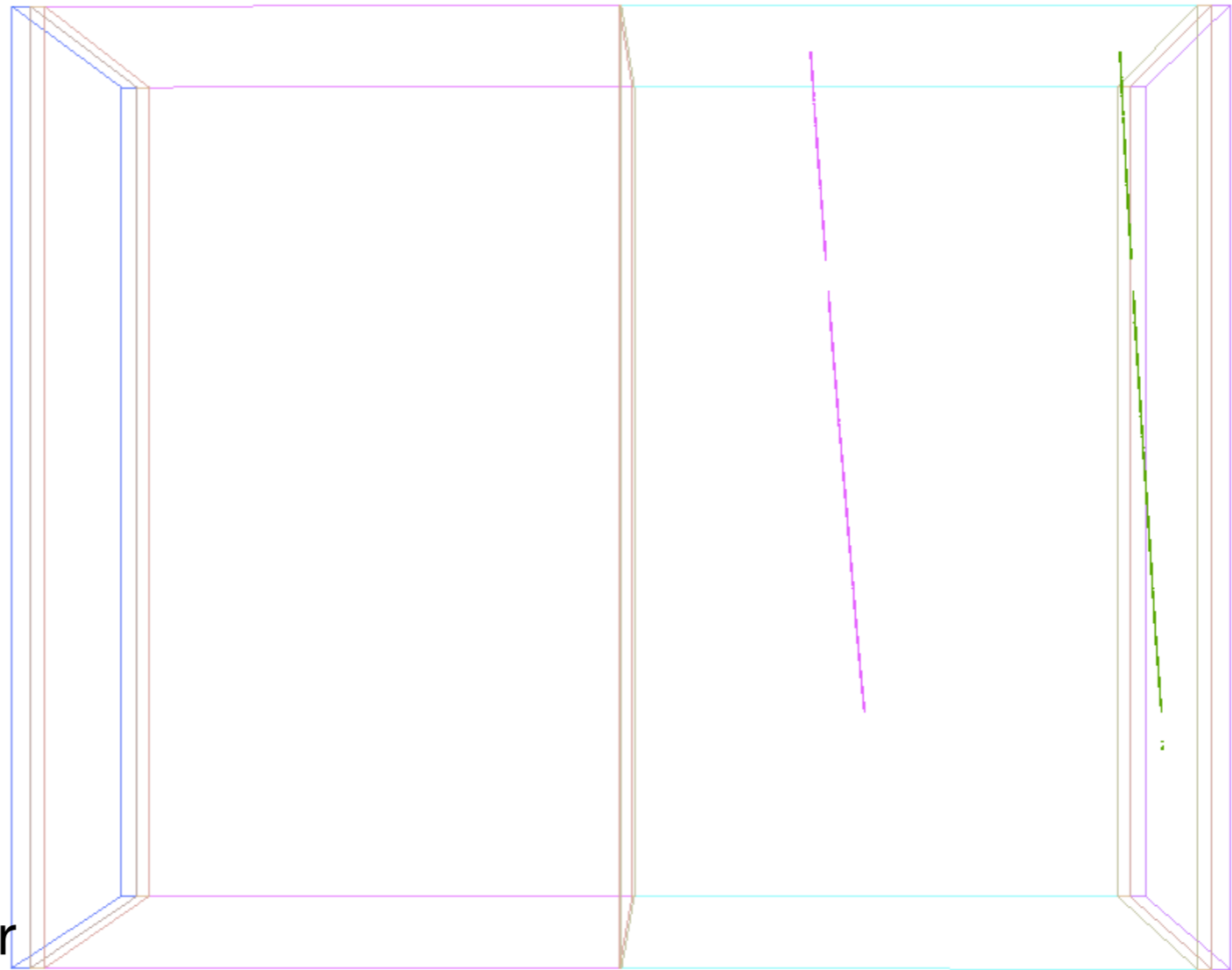
Outer Drift Volume    Central Drift Volume    Central Drift Volume    Outer Drift Volume



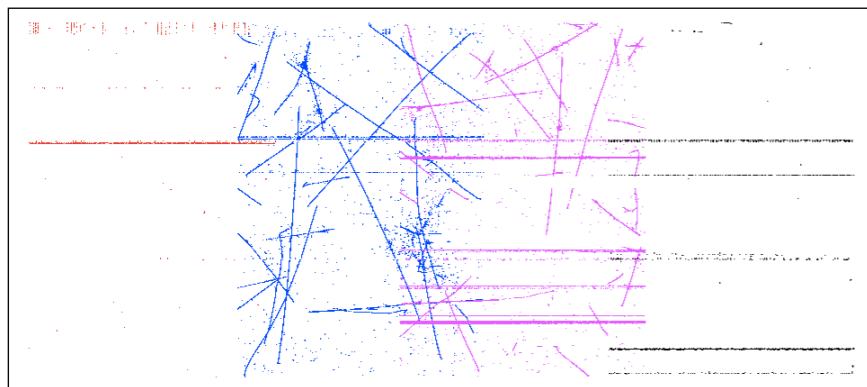




# Stitching In Pandora



Outer Drift Volume    Central Drift Volume    Central Drift Volume    Outer Drift Volume





- Pandora is setup to stitch tracks crossing the APA. A minor modification to LArContent is required for this and I will work on getting this released into LArSoft soon.
- The cut value of 5cm for particle length needs optimising. In all cases considered for this event it seemed to work well, but a more detailed study is needed.
- There is also the possibility of running a downstream analysis to use APA hits to tag tracks for the case where Pandora cannot reconstruct a full 3D particle from the hits.

Thanks for your attention!

Comments or Questions?



# Pandora Pattern Recognition



Pandora is an open project and new contributors would be extremely welcome. We'd love to hear from you and we will always try to answer your questions.

Pandora SDK Development

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<https://github.com/PandoraPFA>



<https://pandorapfa.slack.com>

