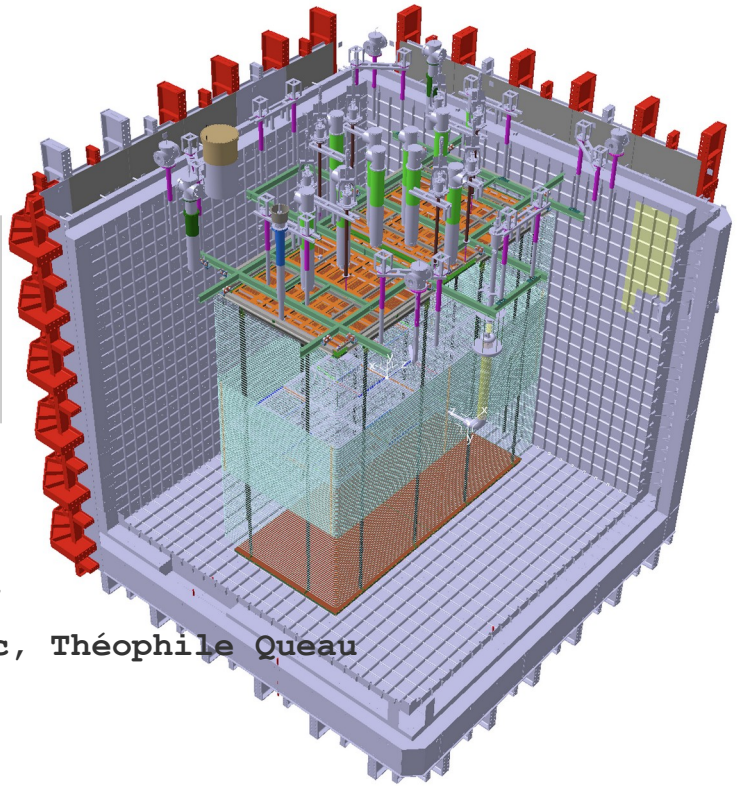
Testing the reconstruction in PD-VD: disambiguation



FD Sim/Reco meeting

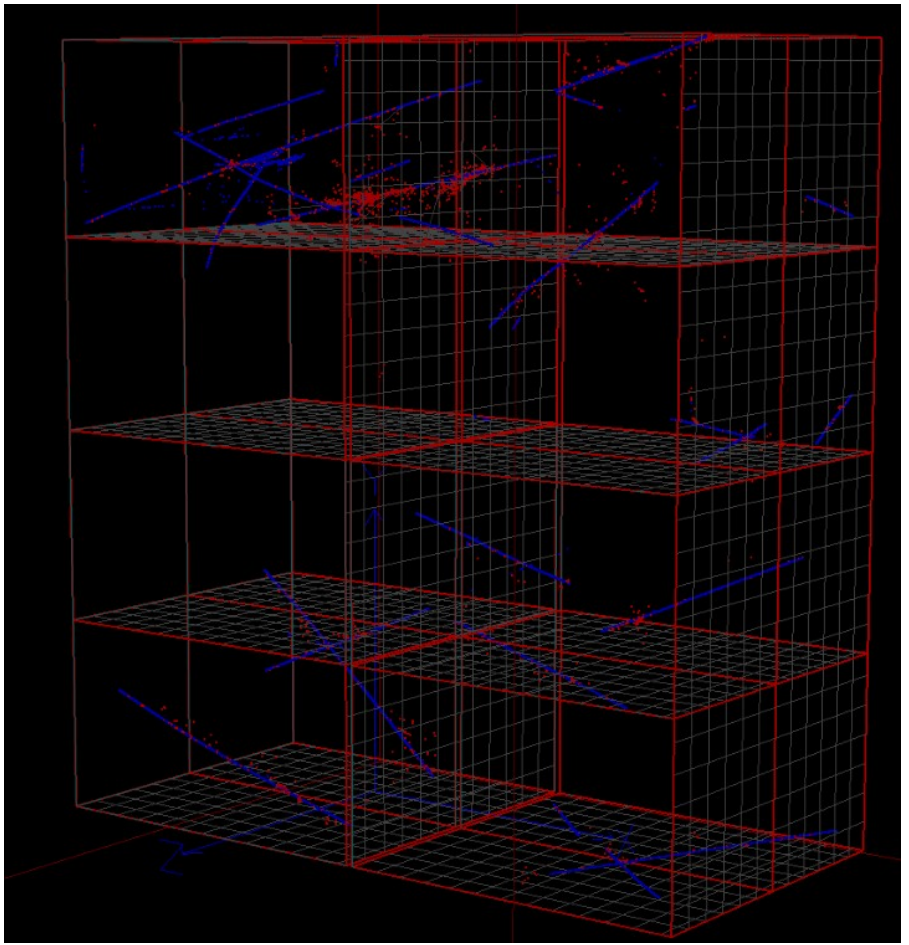
Mateo Bedes, Thibaut Houdy, Yoann Kermaidic, Théophile Queau

5th of June, 2023

Using the ProtoDUNE-VD simulation

Already available since LArSoft v09_65_03:

1. **protodunevd_standardsingle_driftX.fcl**
   gen_protodunevd_beam_p1GeV.fcl
   gen_protodunevd_cosmics.fcl
2. **protodunevd_g4_stage1.fcl**
3. **protodunevd_g4_stage1.fcl**
4. **protodunevd_detsim.fcl**
5. **protodunevd_reco.fcl**



- What about reconstruction ProtoDUNE-VD?
- What about disambiguation with Pandora (gaushit or hitpdune)?

- How to investigate these points?

Development of a LArSoft module

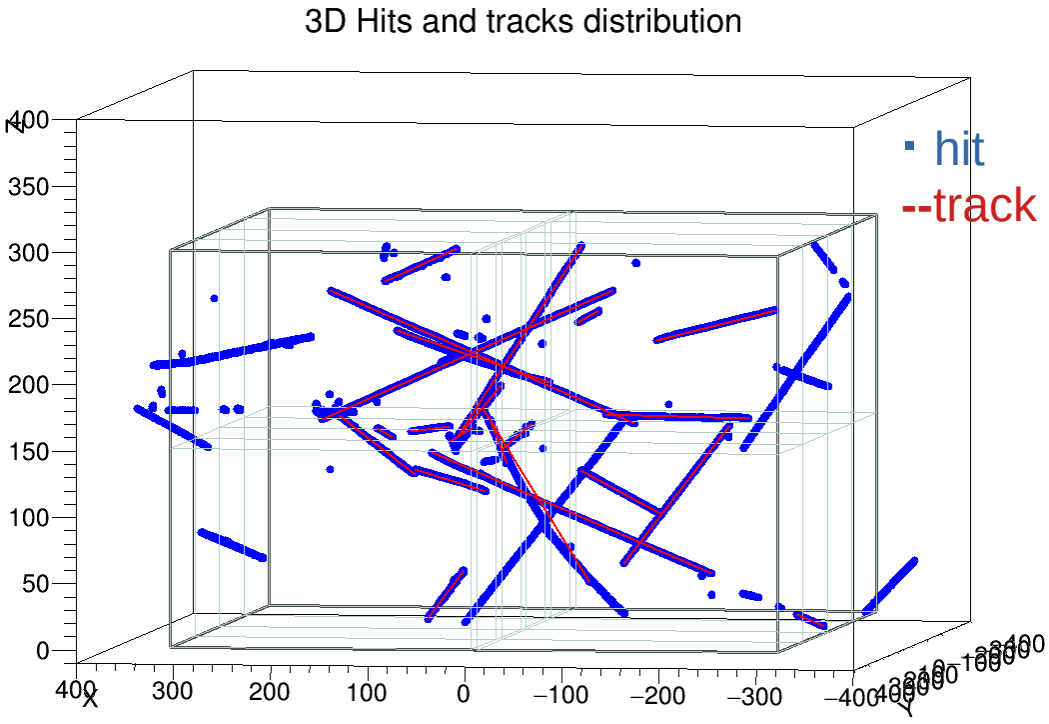
Module description:

- Access to all the hits (wire, time, TPC)
- Access to the start and the end of the tracks using track→Start() and track→End() geoPoint methode.

No time for the start and the end of the track yet. Suggestions?

3 different displays :

- **3D**



1 cosmic event ProtoDUNE-VD
(Double Phase Corsika)

Development of a LArSoft module

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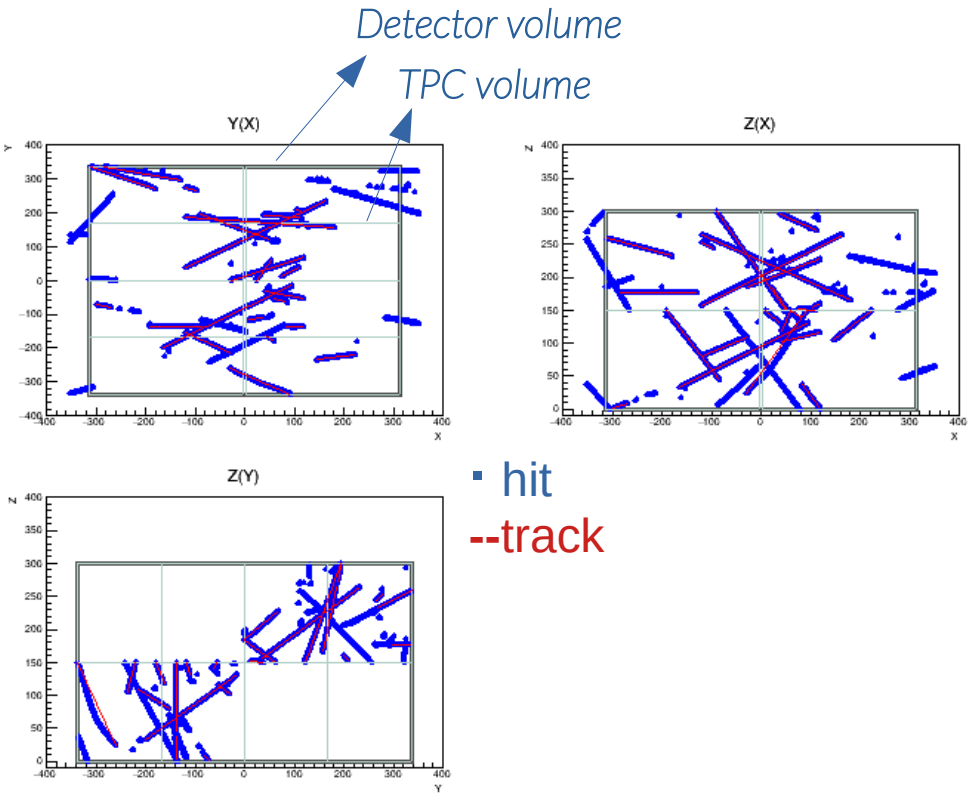
Suggestions?

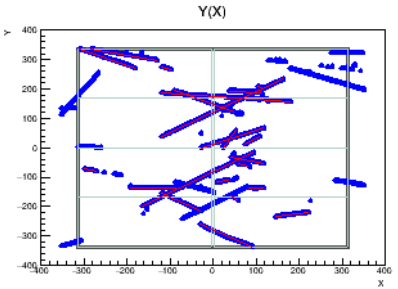
3 different displays :

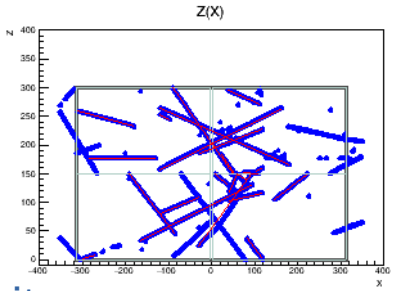
- 3D
- **2D**

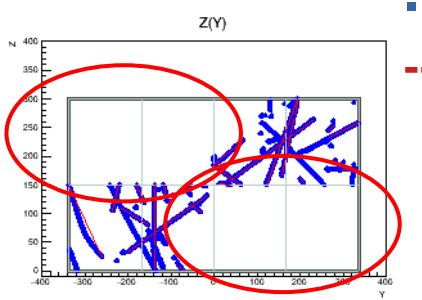


1 cosmic event ProtoDUNE-VD
(Double Phase Corsika)

Cosmics with ProtoDUNE-VD





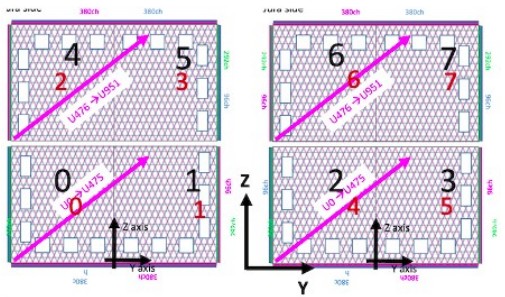


- hit
--track

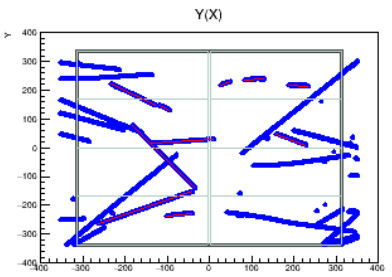
v09_65_03

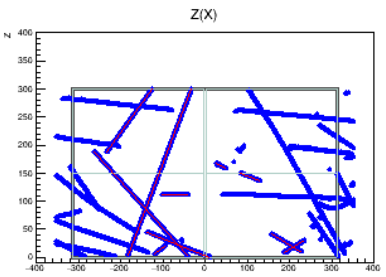
- Problem already spotted by Wenqiang : identified as coming from the numbering scheme of the TPC

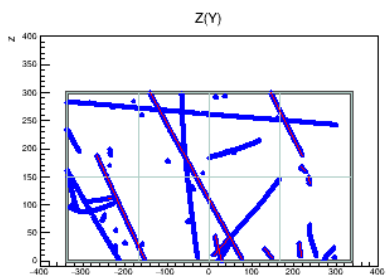
- W. updated the GeoObjectSorterCRU60D and now the TPC numbering is continuous in a CRM-> from v09_70_00 on, problem solved



Red = new numbering



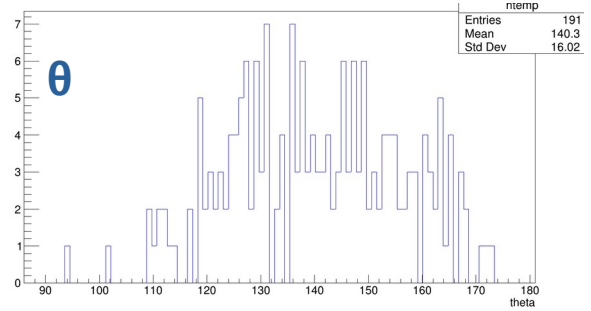


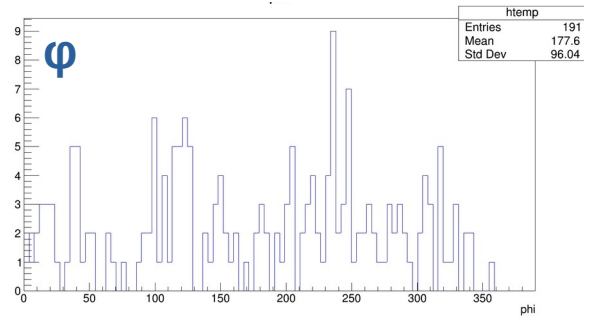


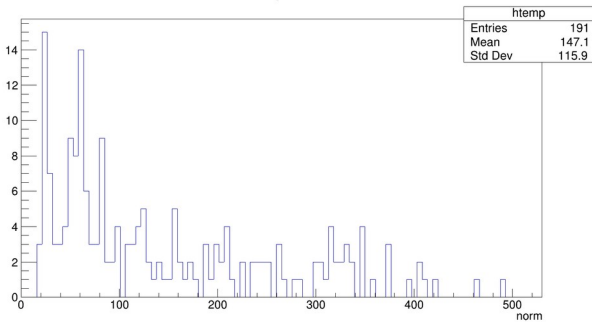
- hit
--track

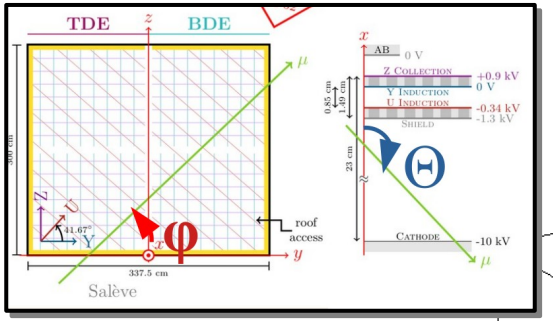
v09_70_00

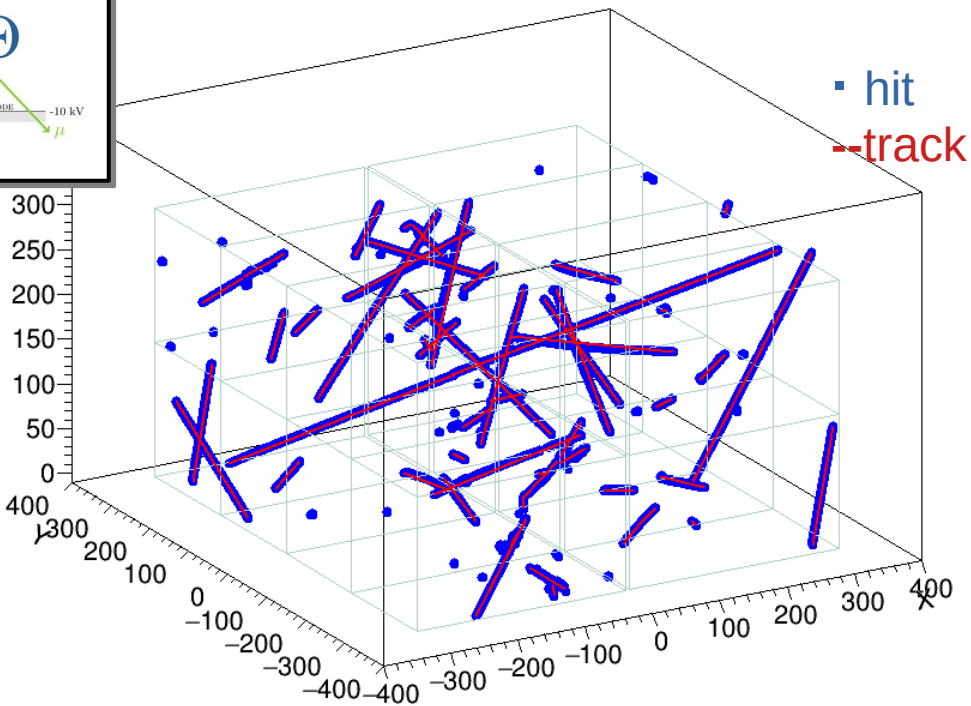
Cosmics with ProtoDUNE-VD











1 cosmic event ProtoDUNE-VD
(Double Phase Corsika)

10 cosmic events ProtoDUNE-VD

Development of a LArSoft module

Module description:

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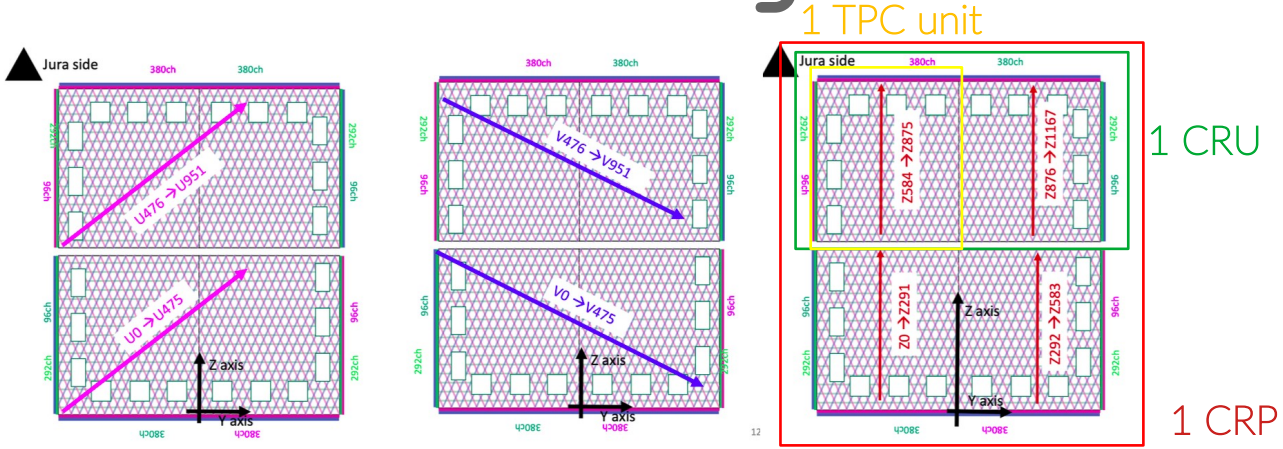
No time for the start and the end of the track yet.
Suggestions?

3 different displays :

- 3D
- 2D

Problem: to test disambiguation, need of a “hit-like” info (wire, time)
→ Projection of the 3D position on the track start and end to the induction/collection plane through the TPC object.

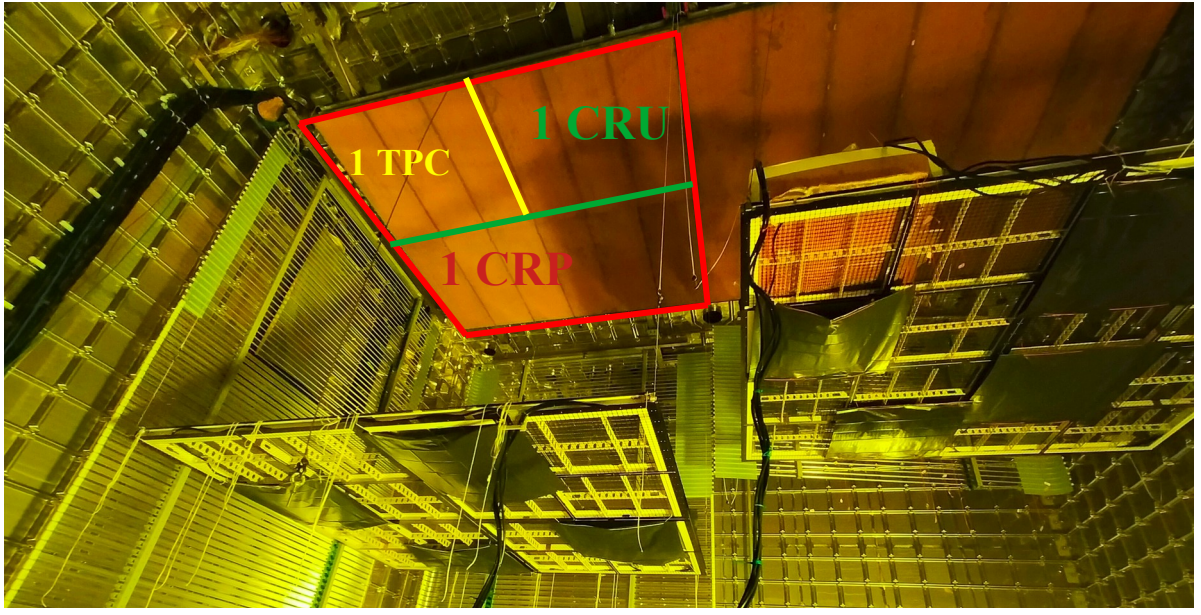
ProtoDUNE-VD disambiguation?



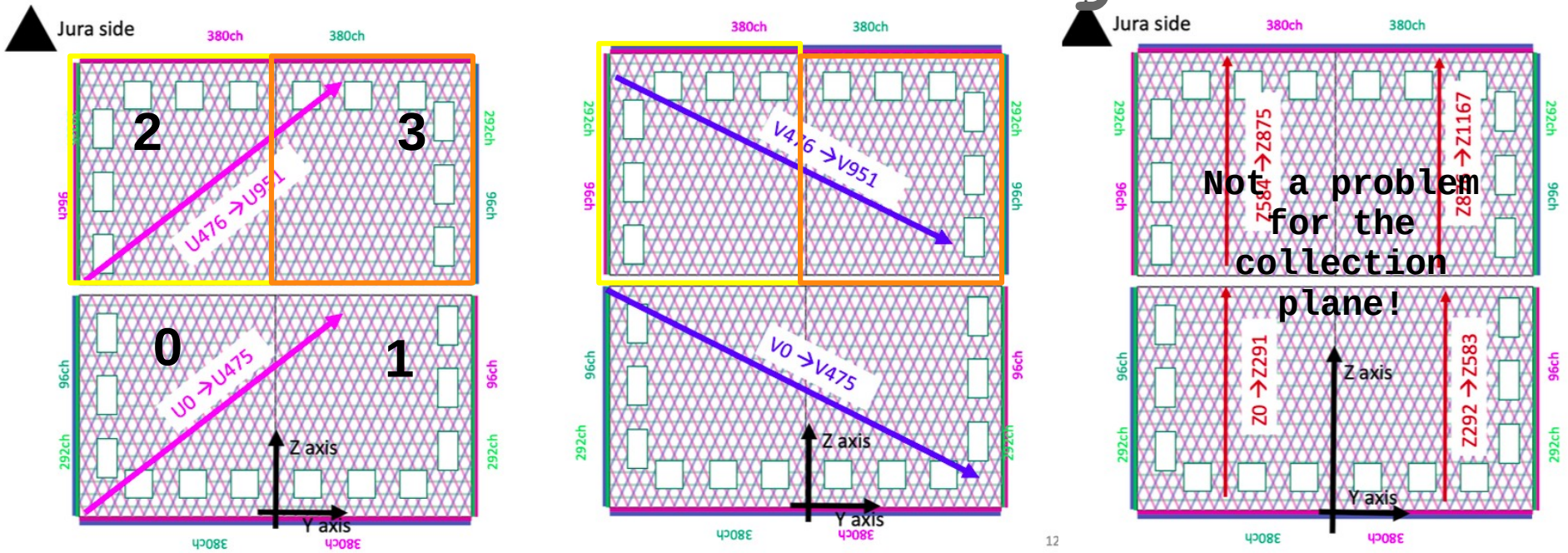
ProtoDUNE-VD :

- 4 CRP
- (2 TDE, 2 BDE)
- → 8 CRU
- → 16 TPC_U per induction/collection

- Hits associated with TPC_U

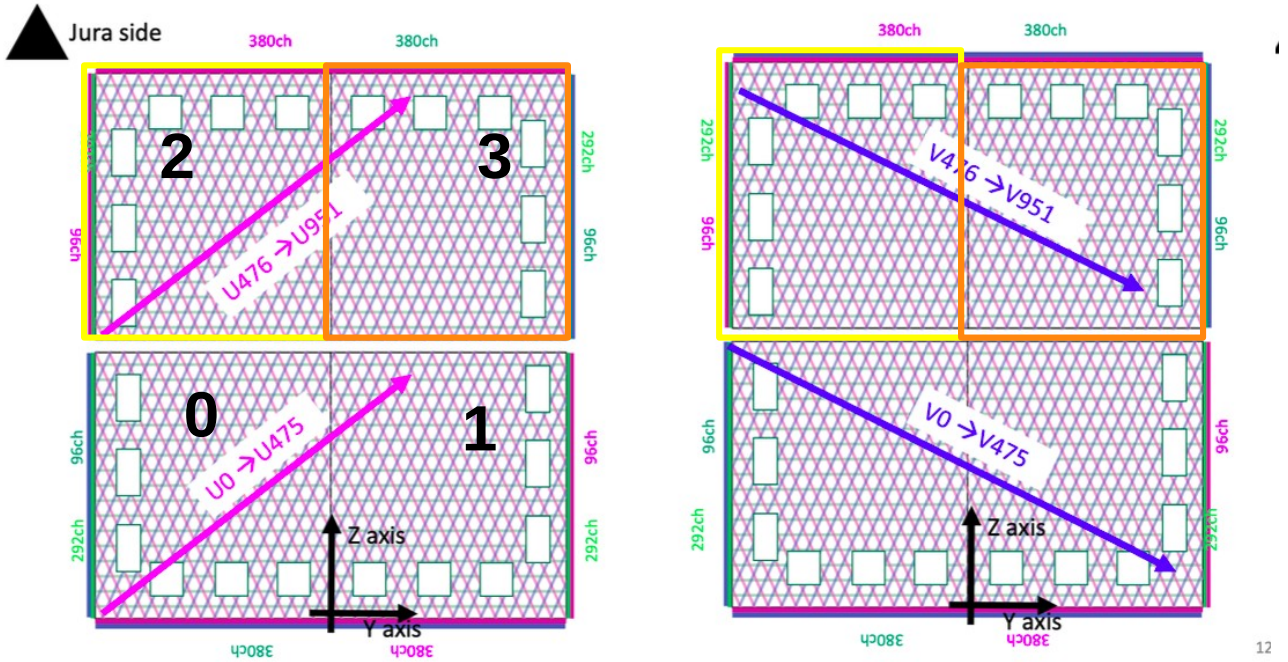


ProtoDUNE-VD disambiguation?



Problem : a hit is associated with a TPC_U even before the reconstruction. What if the hit is wrongly associated with TPC_0 while it is on TPC_1 (ex wire U200)?

ProtoDUNE-VD disambiguation?



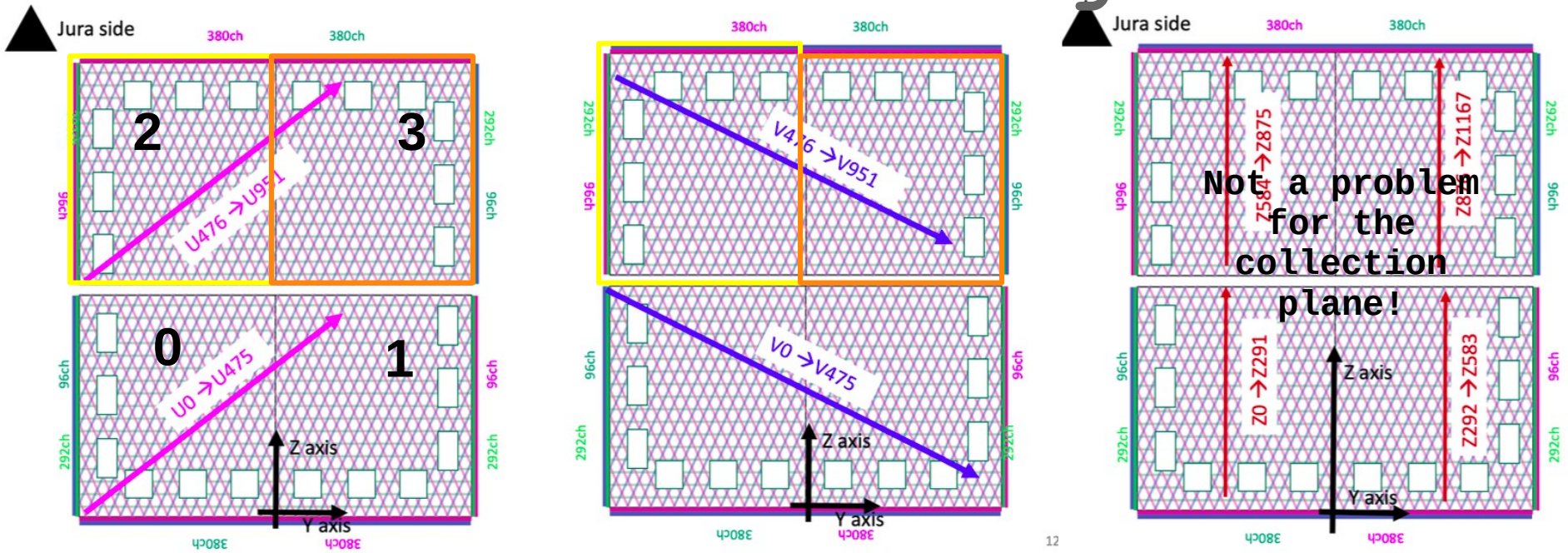

```
reco: [ caldata,
        rns,
        wclsdatavd,
        gaushit,
        reco3d,
        hitpdune
        pandora,
        pandoraTrack,
        pandoraShower,
        pandoraStdcalo,
        pandoraGnocalo #,
        ]
```

Problem : a hit is associated with a TPC_U even before the reconstruction. What if the hit is wrongly associated with TPC_0 while it is on TPC_1 (ex wire U200)?

A crossing wire is automatically associated with both TPCs until disambiguation can tell where the hit belongs. **Hitpdune** routine disambiguates the gaushit distribution after reconstruction.

```
physics.producers.pandora.HitFinderModuleLabel:              "hitpdune"
physics.producers.pandoraWriter.HitFinderModuleLabel:        "hitpdune"
```

ProtoDUNE-VD disambiguation?



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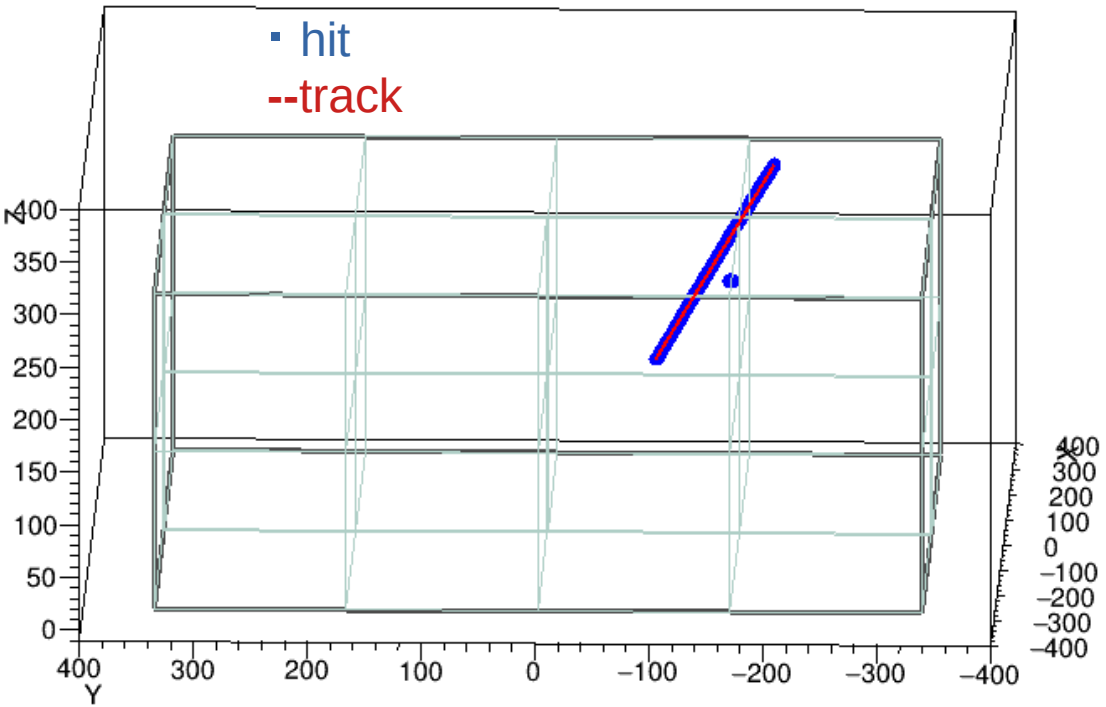
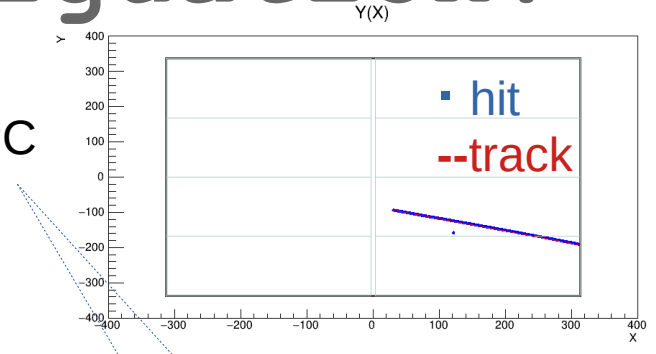
A crossing wire is automatically associated with both TPCs until disambiguation can tell where the hit belongs. **Hitpdune** routine disambiguates the gaushit distribution after reconstruction.

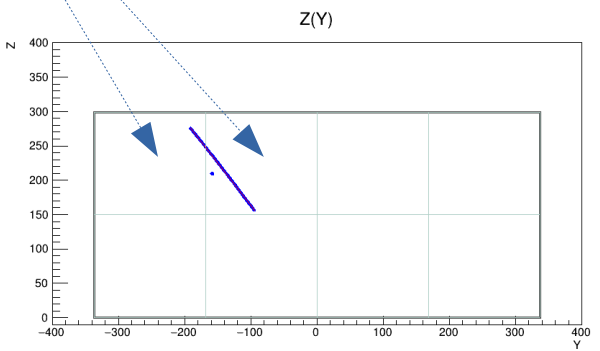
- Is hitpdune correctly working on ProtoDUNE-VD?
- What about Pandora? Does it succeed to reconstruct tracks crossing different TPC_Us?

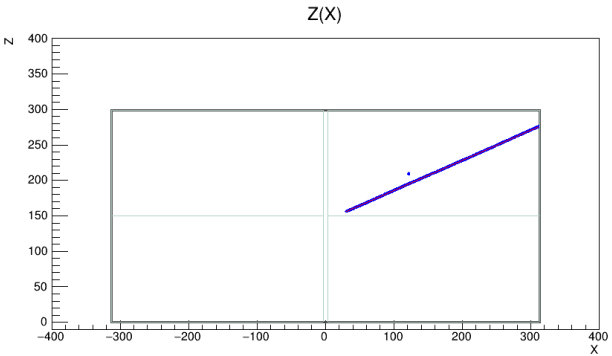
ProtoDUNE-VD disambiguation?

To test, single muon in ProtoDUNE-VD crossing different TPC









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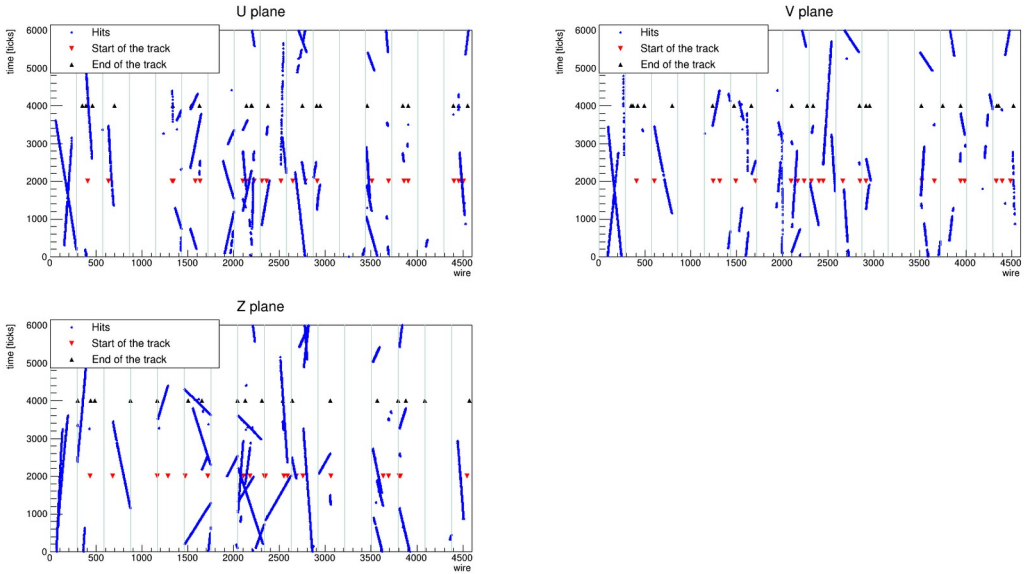
No time for the start and the end of the track yet.
Suggestions?

3 different displays :

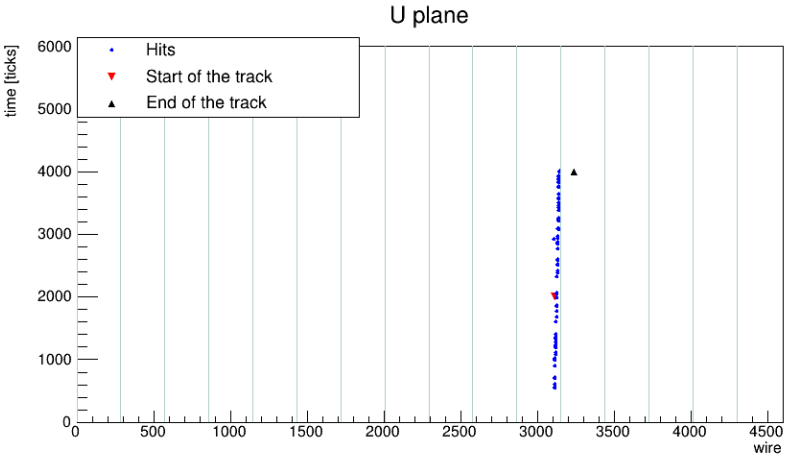
- 3D
- 2D
- **TPC view**

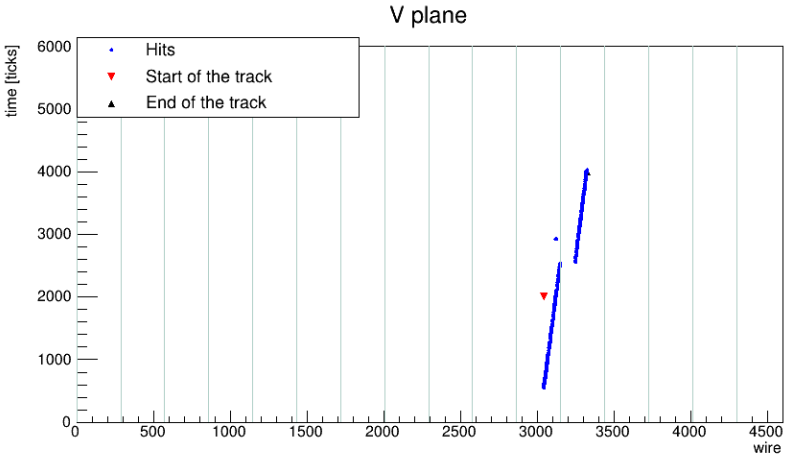


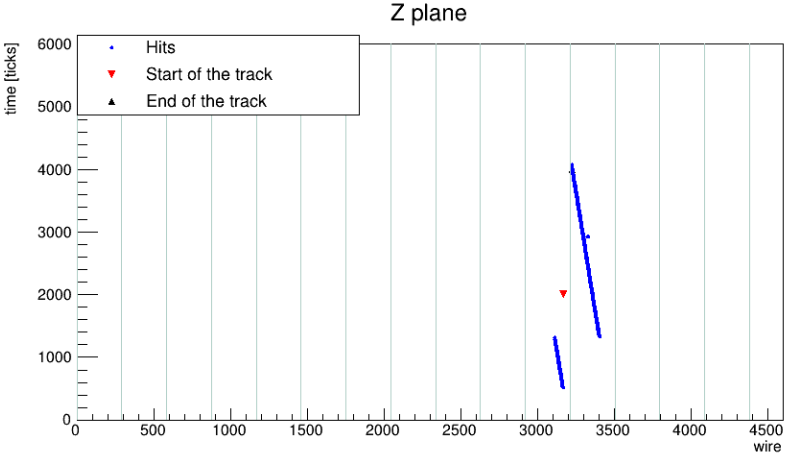
Problem: to test disambiguation, need of a “hit-like” info (wire, time)
→ Projection of the 3D position on the track start and end to the induction/collection plane through the TPC object.

Wire
Unique ID from
0 to about 4700
(local TPC wire + previous TPCs total number of wires)

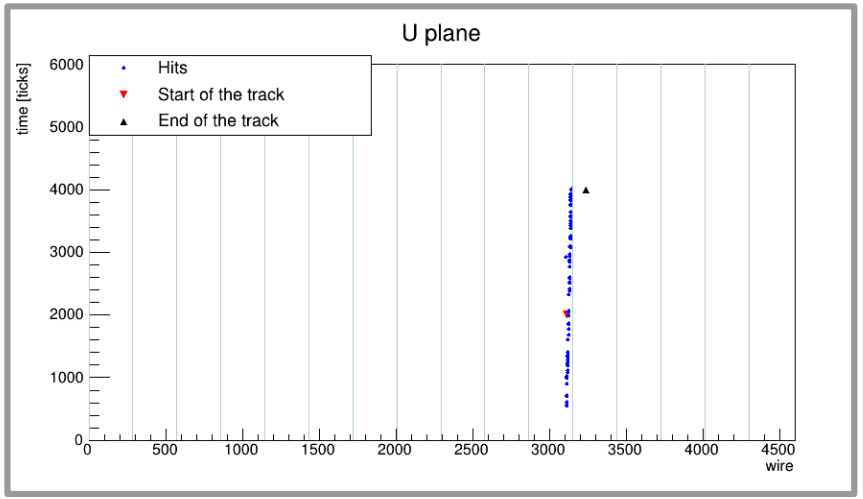
ProtoDUNE-VD disambiguation

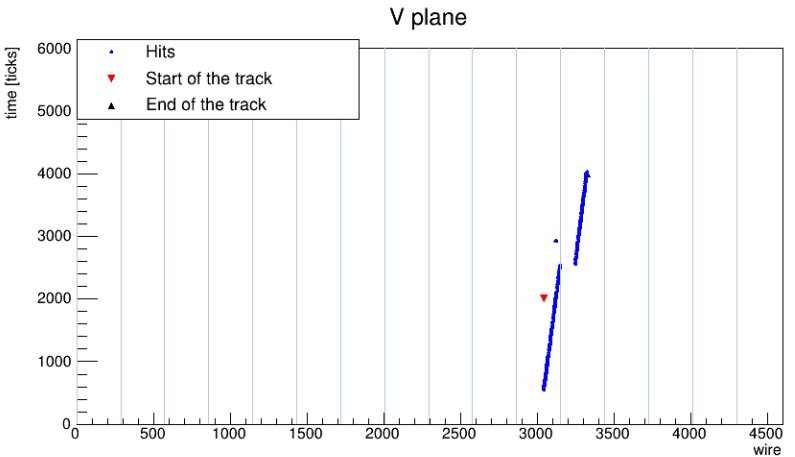


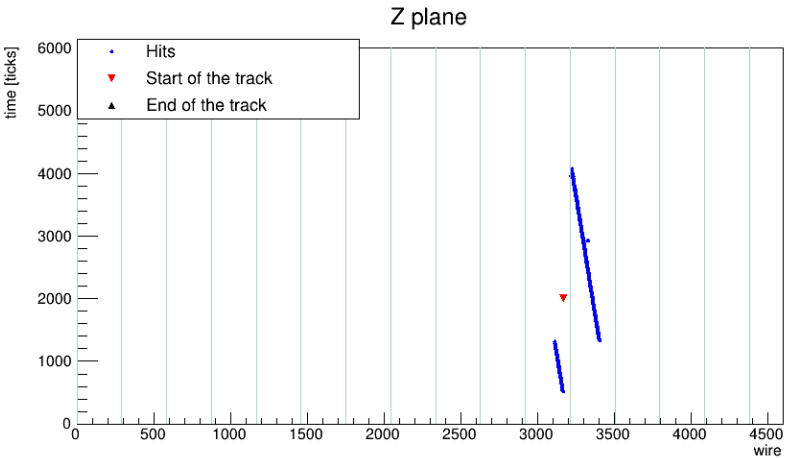




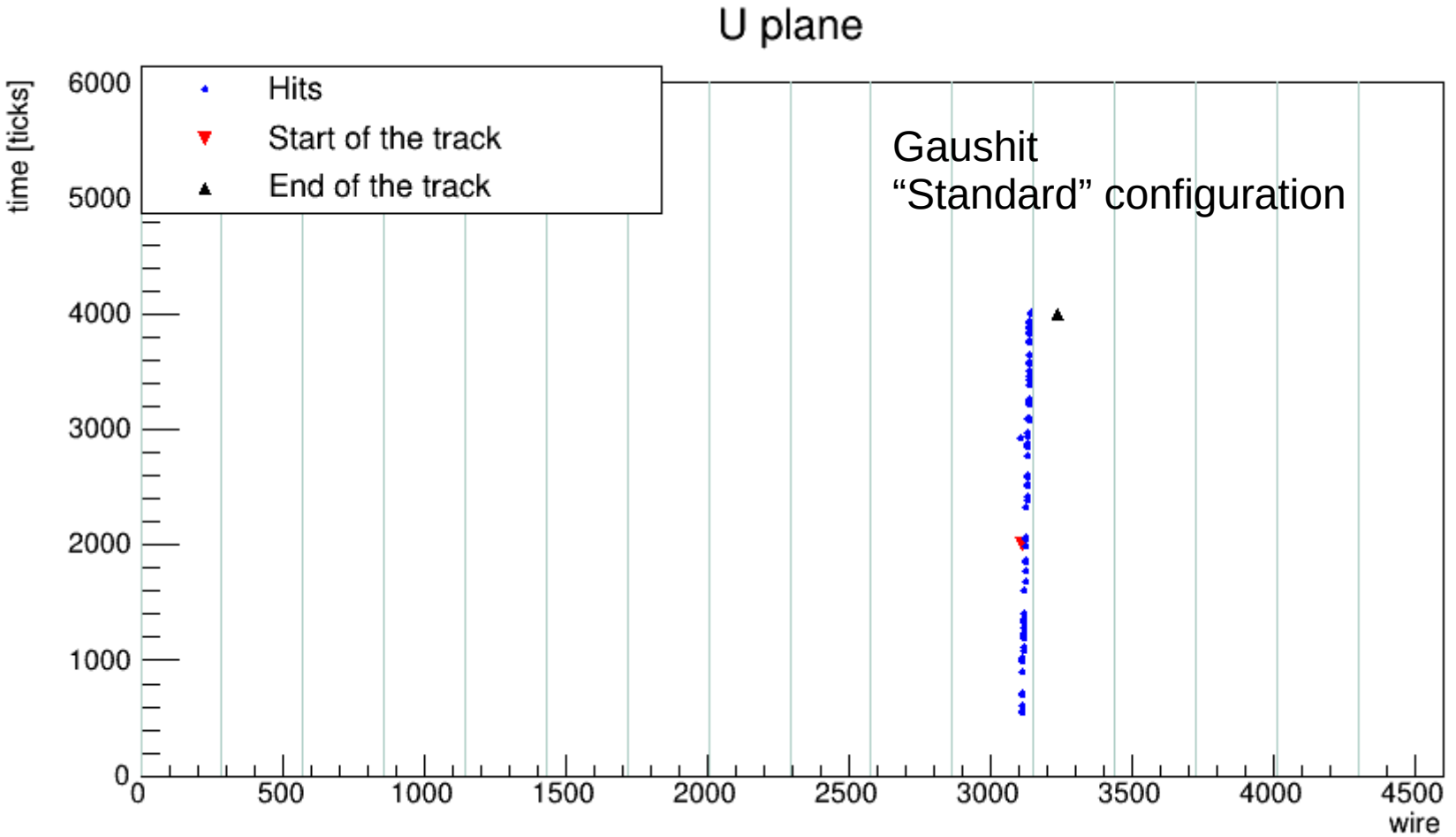
ProtoDUNE-VD disambiguation





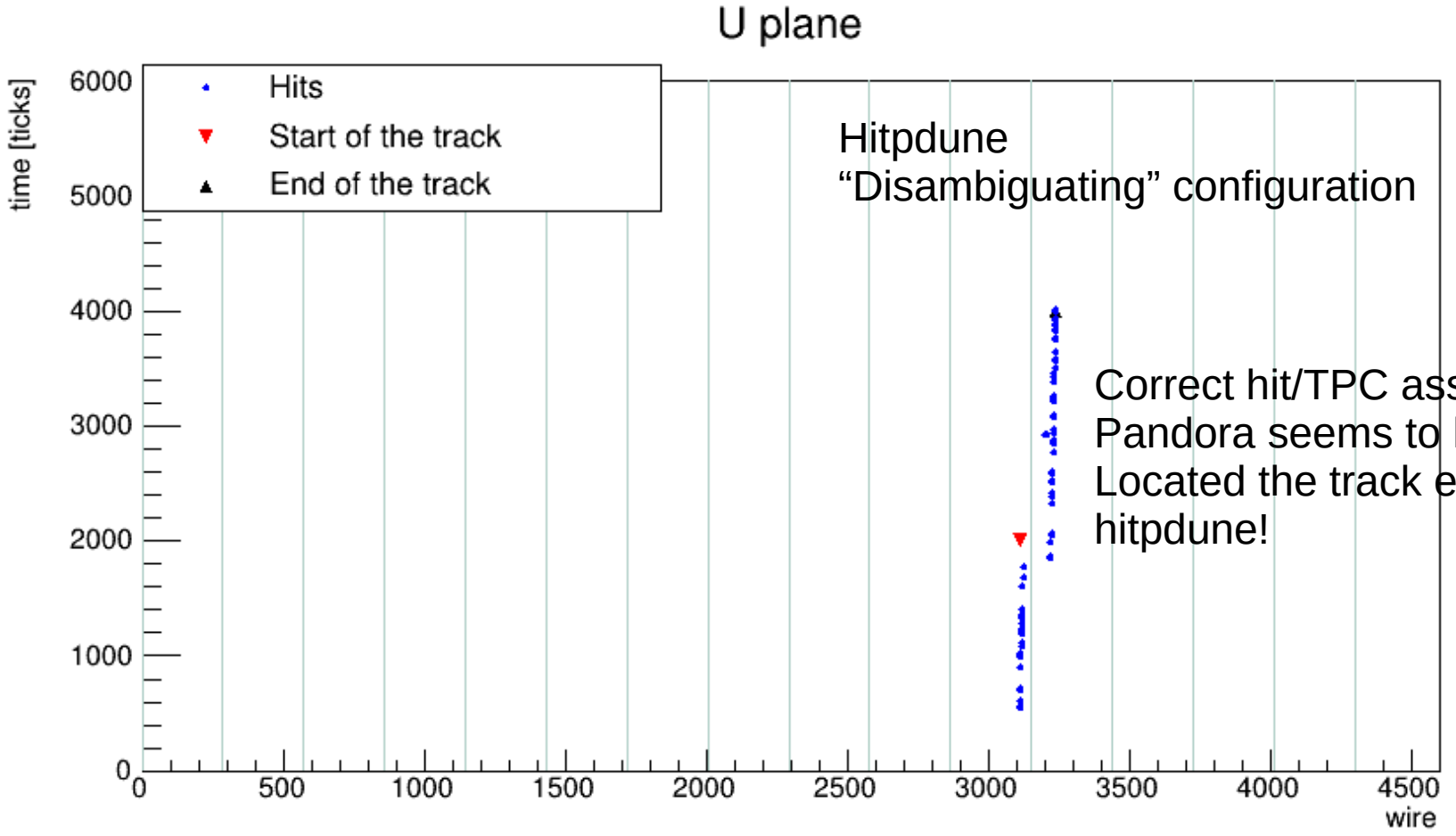


ProtoDUNE-VD disambiguation



Problem: hits are only associated with the 1st TPC$_U$

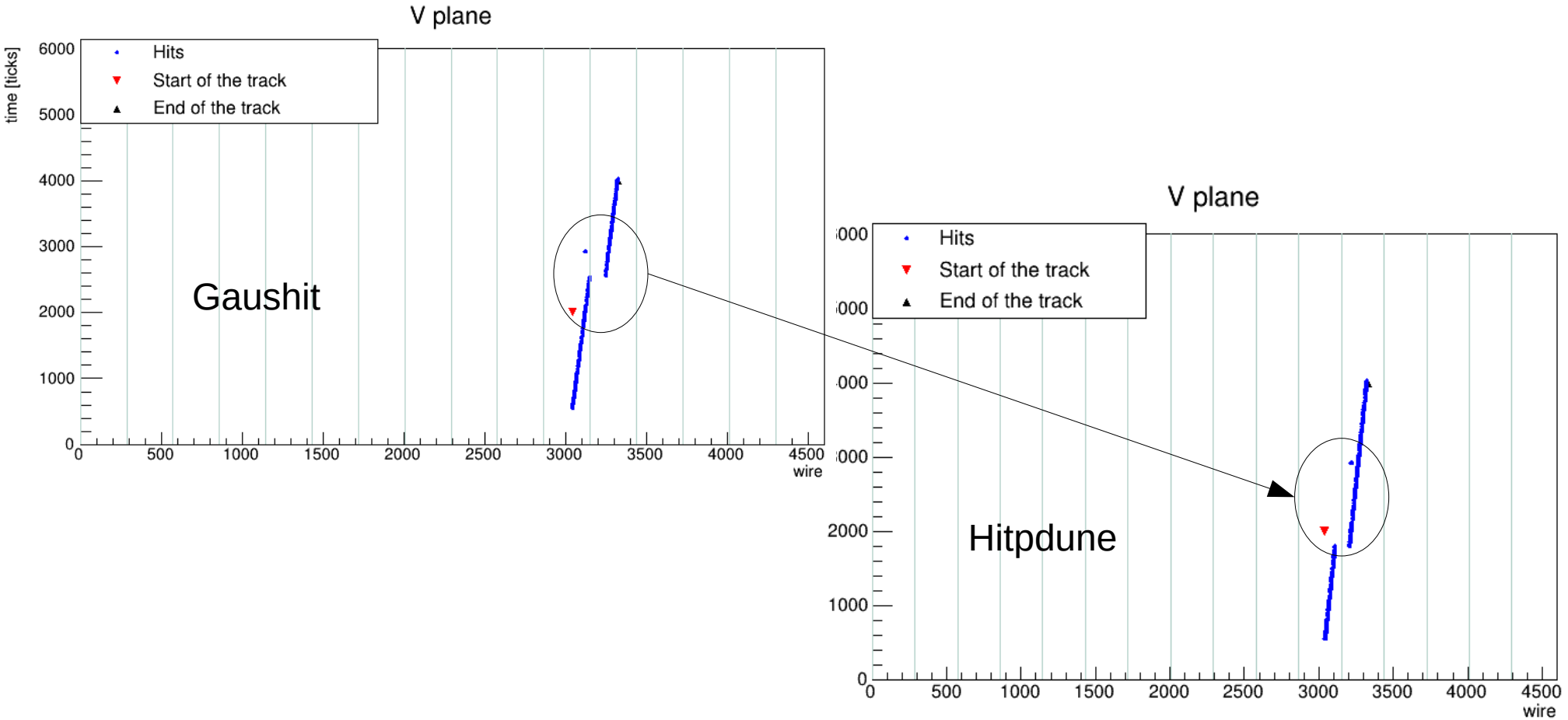
ProtoDUNE-VD disambiguation



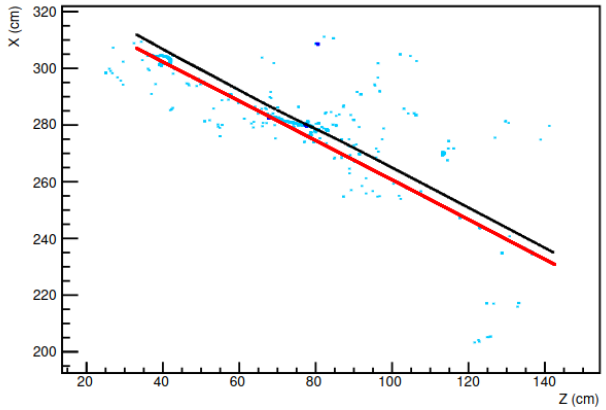
Hitpdune
“Disambiguating” configuration

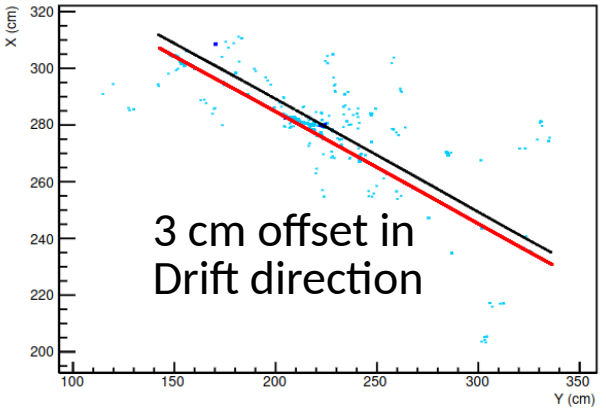
Correct hit/TPC association
Pandora seems to have correctl
Located the track even without
hitpdune!

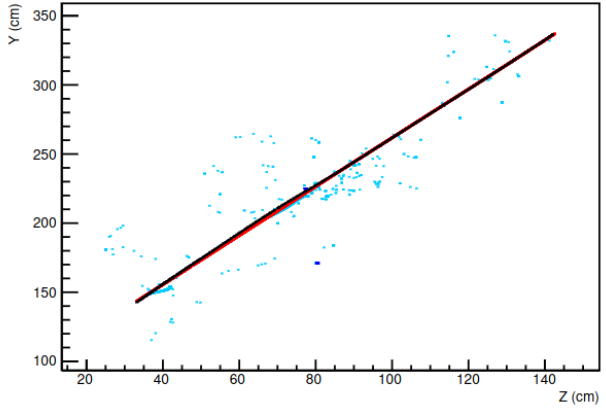
ProtoDUNE-VD disambiguation



Further testing : simple muon







Particle list:

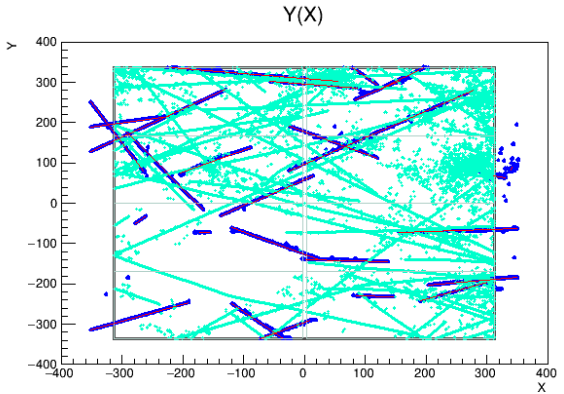
- e^-
- e^+
- μ^+

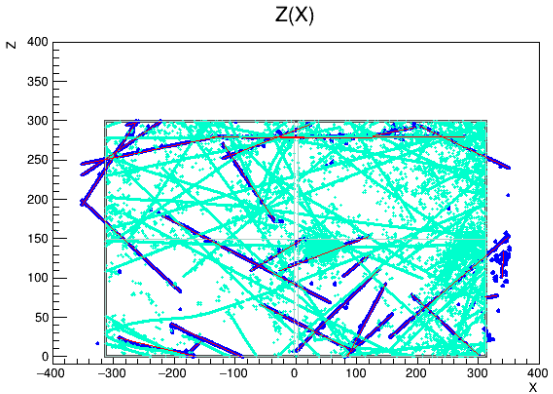
Muon 1 GeV in PDVD

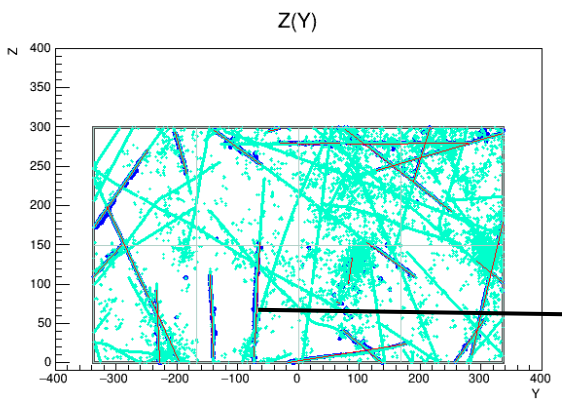
Comparison with Geant4 simulation Depositions

Y. Kermaidic's work

Further testing: cosmics

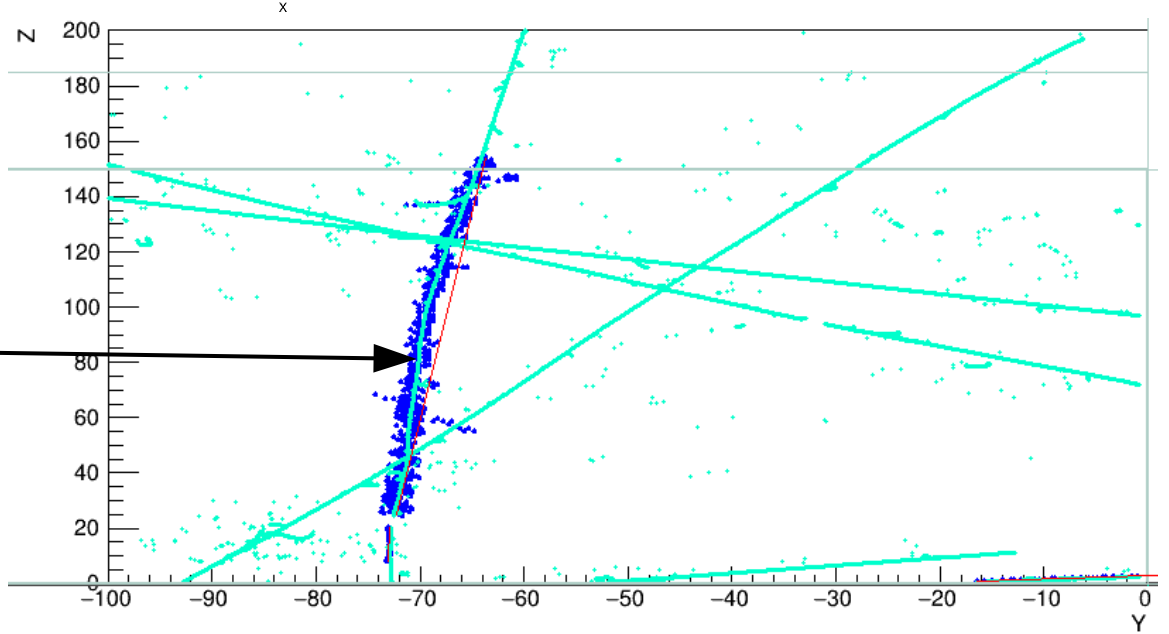




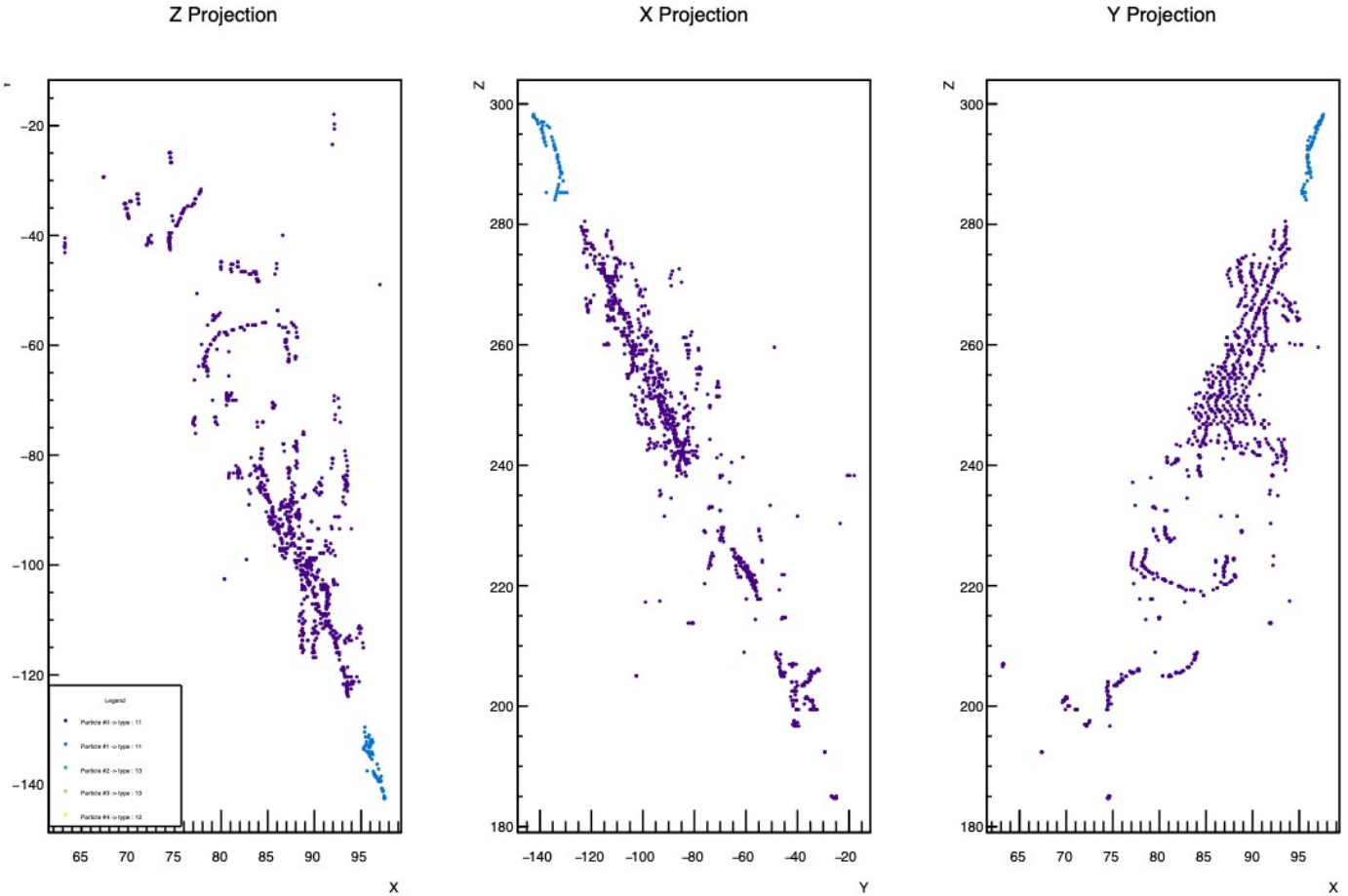


- hit
- track
- depo

Investigating
1. energy deposits throughout the top/bottom volumes
2. Pandora shower reco (efficiency, purity, resolution, etc)



Further testing: shower



1 GeV/c electron in PDVD

Investigating
1. energy deposits throughout the top/bottom volumes
2. Pandora shower reco (efficiency, purity, resolution, etc) → for now using default FDVD config and neutrino reco option

Work of M. Bedes and T. Queau (interns)

To be reported at the VD-sim/reco WG

Conclusion

1. Disambiguation seems to work as expected. Pandora seems to be able to disambiguate alone.

2. Disambiguation will be tested on more complex events like shower

3. Should we gather a common effort to live without this TPC index in the reconstruction frame? Is it viable for FD?

4. Extensive testing of the PD-VD simulation and reconstruction : target is to be ready for massive production

5. Gaining expertise on track/shower identification with PD-VD