

Near detector workshop, March 2017, Fermilab

WARWICK
THE UNIVERSITY OF WARWICK

TREx Reconstruction for High Pressure GAr-TPCs

Jennifer Haigh, Paula Denner & Sammy Valder

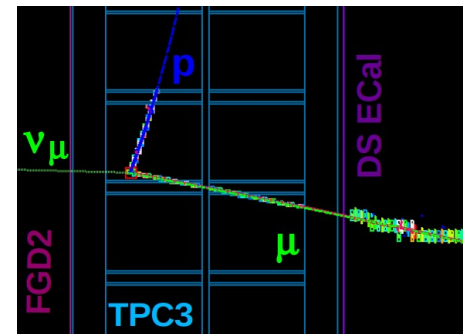
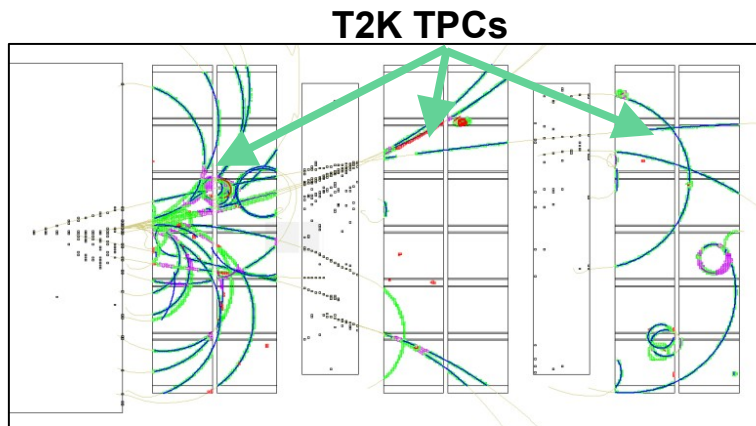
The Origins of TREx

The Natural Habitat

TREx was developed to cope with reconstructing vertices in the 3 large Argon-Gas TPCs in ND280

- Needed to be fully 3D i.e. no assumptions about forward going tracks or vertex position ⇒ **Homogeneity & Isotropy**
- **As physics-agnostic as possible:** Lets analysts decide whether something is a vertex or a secondary interaction.

Good reconstruction of delta-rays (distinguishing tightly curled/curved track from sharp kinks (potential nu-interaction))

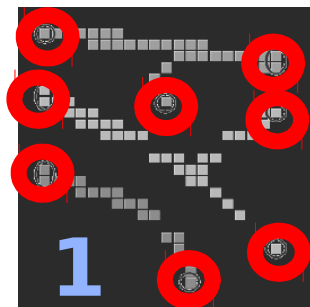


Gas Interaction in ND280.
T2K Argonuts Group

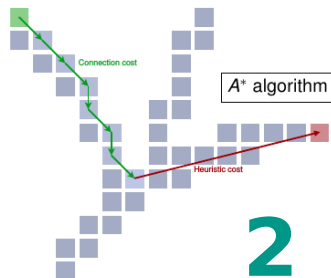
The Pattern Recognition

The Guts of TREx

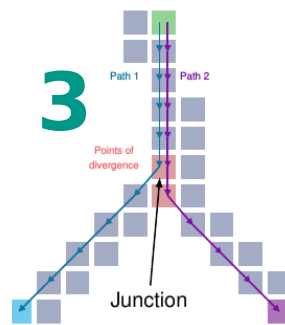
- TREx uses the A* Algorithm for pathfinding
 - Paths are formed according to connection cost factors between pattern edges.
 - Diverging paths are used to identify junctions.
 - Kink-finding can distinguish hard scatters from curved tracks



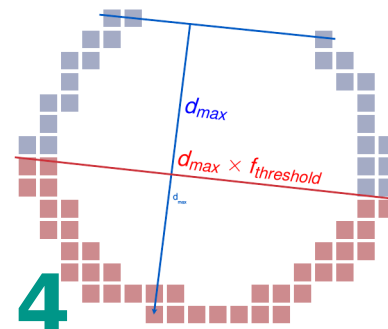
Edge
detection



Path finding



Junction
finding



Kink finding

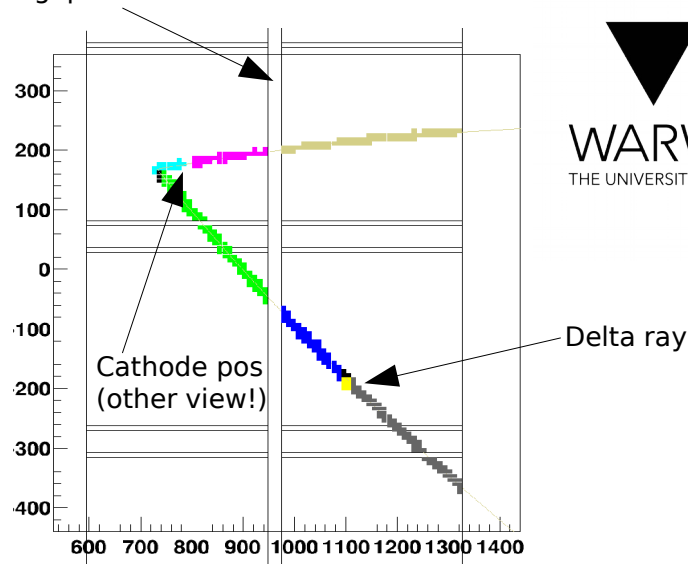
Learn more: [TREx tutorial](#)

<http://www.t2k.org/nd280/physics/xsec/subgroup/TPCInteractions/meetings/gas-interactions-2016-06-17/eddy-patrec-tutorial-2016-17-06/view>

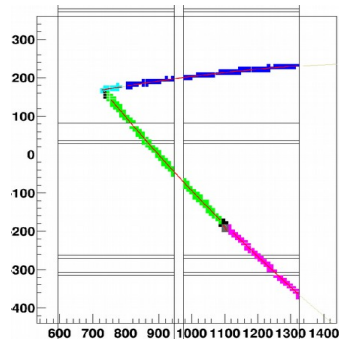
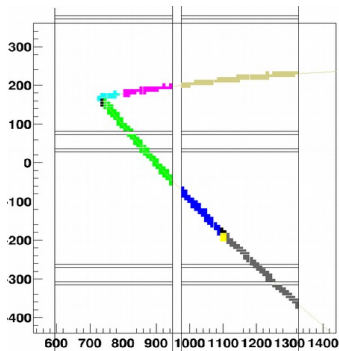
Fitting and merging

- TREx uses a likelihood fitter to fit a helix model to paths
- Find momentum, match to tracks in other subdetectors.
- Tracking used for PID, available for analysis code.
- Match and merge tracks across junctions and detector gaps.
- Recover through-going tracks from, e.g. delta ray emission.

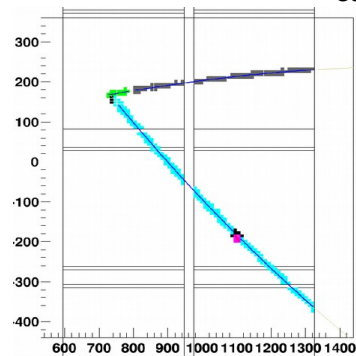
Readout gap



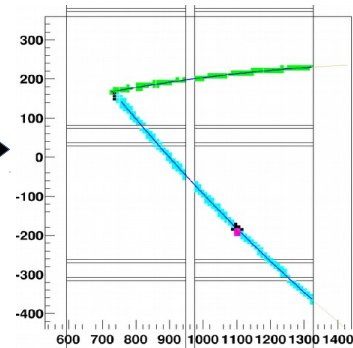
Merge across detector gaps



Merge across junctions



Merge across cathode



TREx unleashed

Into the Wild

- The package is now standalone and independent of T2K software.
- DUNE is considering using HPTPC technology (or a hybrid) as its Near Detector option so Warwick has been working on reconstructing the near detector simulation with TREx.
 - An often mentioned concern with HPTPCs are the large backgrounds from heavy materials surrounding the detector, so good reconstruction is key.

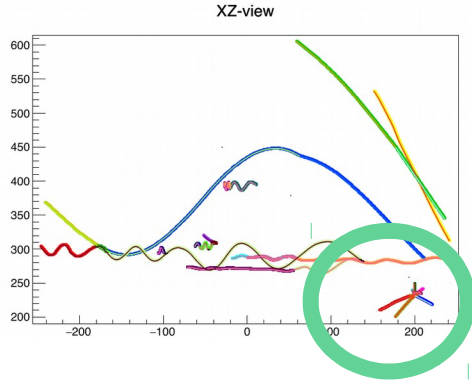
DUNE Simulation input

- Using NDTF simulation output from Justo to test TREx.
 - Have been looking at an “inclusive” sample with events produced anywhere in detector volume => most events come from container walls.
 - Now looking at a new “signal” sample containing only LAr interactions.
- MC output is voxelised.
 - Remove possible artifacts due to matching hits between views for 2D+2D readout. Assume that TREx will not have to do this disambiguation.
 - Also assume t_0 has been correctly identified.

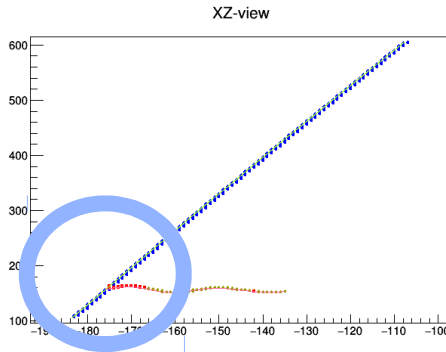
Initial testing

Event displays from inclusive sample

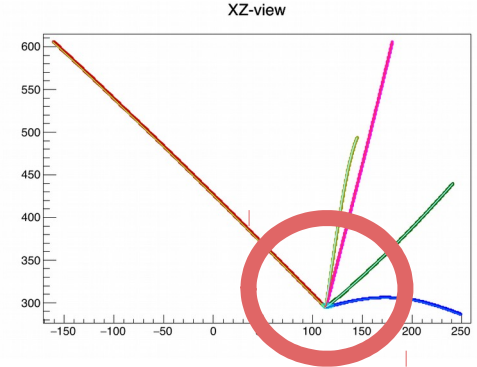
- Not very many interactions within active volume.
- Generally works well for straight tracks; sometimes splits tracks in tight helices.



Reconstructing genuine gas interaction vertices in the presence of such backgrounds is paramount!



Recovery of through going Tracks from paths that got 'broken' by delta ray emission, using likelihood Matching & Merging



The pattern recognition produces Junctions that can be used to identify true Vertices in the gas.

Developments for DUNE

Into the Wild

- Will be able to better identify pathologies with new event sample.
- TREx currently fits and merges tracks assuming constant helix parameters along whole track.
 - DUNE ND would have larger TPCs+denser gas than ND280 – helices spiral inward and this must be accounted for.
 - Merge tracks based on local linear fit near junctions?
- Different backgrounds, different surrounding material/subdetectors.
 - New code for t0 determination, using other detectors to match/veto TPC tracks.
- Lots of testing/tuning!

Thank you for listening!

