GArSoft Tracking Update

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DUNE ND Meeting

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Recent Work

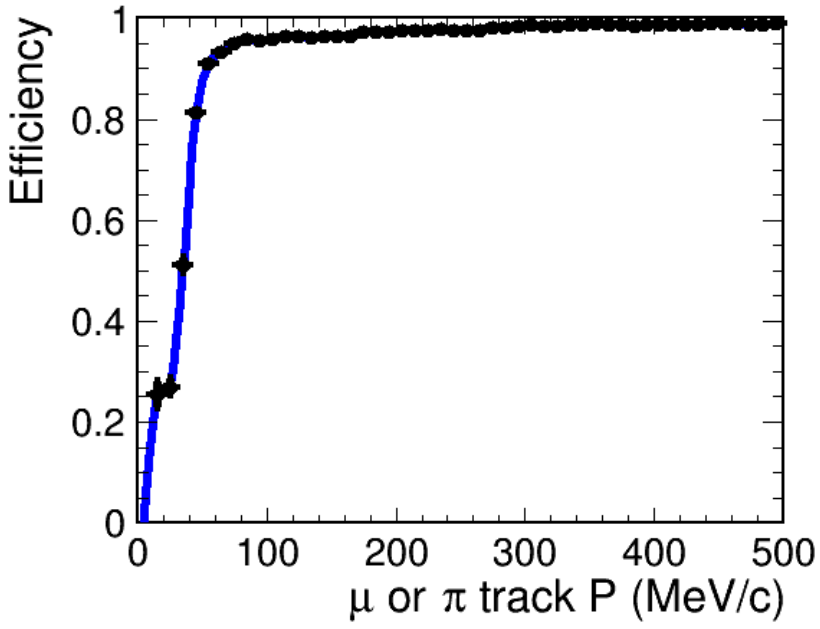
- New Tracking Note: DUNE-Doc 13933. Authors: T. Junk, E. Brianne, T. Campbell, L. Bellantoni
- Describes (briefly)
  - Software structure
  - Event generators
  - Detector simulation
  - Hit finding, hit clustering, pattern recognition, fitting
  - Track parameters and data products
  - Tracking performance
- ECAL note to be produced separately

Recent Work

- Addressing lower-momentum particles.
  - Pattern recognition sometimes correctly clustered vector hits into long, looping tracks, but the fit gave crazy results.
  - Rewrote the hit-sorting algorithm. Now start at one extreme end and "walk" along the track to order the hits to give to the fitter
  - Had problems with this sort before with hits that didn't make it on the list, and the algorithm went back and added them to the end. Now have better criteria for adding stray hits on the sides of tracks.
  - Still some work to do to figure out what to do about scatters and delta rays
  - Tight curlers still broken into many pieces. May have to resurrect the X-sort for those tracks.
- Vector-hit finder now takes the hits that have the largest residuals and attempts to reassign them, picking the best VH from ones already found
- And I got the CRY generator working. Makes just one muon at a time

Tracking Performance: $\pi^{\pm}$ and $\mu^{\pm}$

Estimated using Leo's sample of ν_{μ} events with the optimized LBNF FHC spectrum



Charged pion and muon tracking efficiency

Electrons are similar, but including them produces a kink at 20 MeV (bigger than the one that's there).

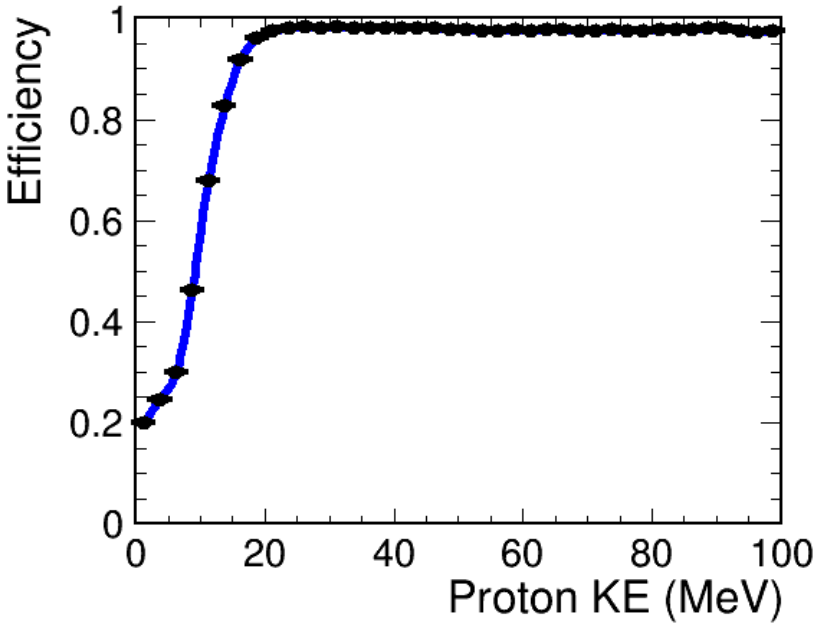
Low-energy electrons curl around – only partial efficiency for them

Low-energy pions and muons stop – have a track length cut of 20 TPC Clusters

Protons with P<150 MeV have very little KE and thus stop quickly – plot their efficiency vs. KE

Tracking Performance: Protons

Estimated using Leo's sample of ν_μ events with the optimized LBNF FHC spectrum



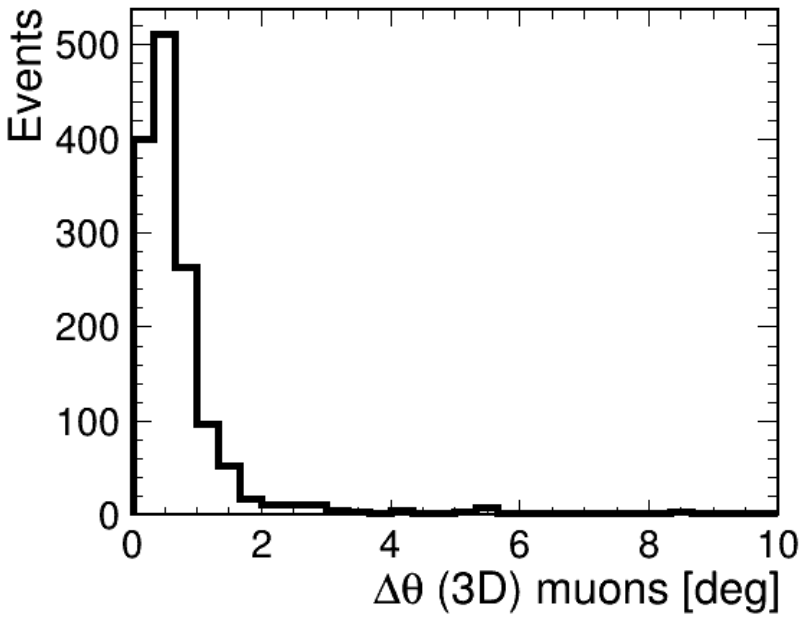
Very short track efficiency overestimated near a dense primary vertex due to combinatorics – fake matches.

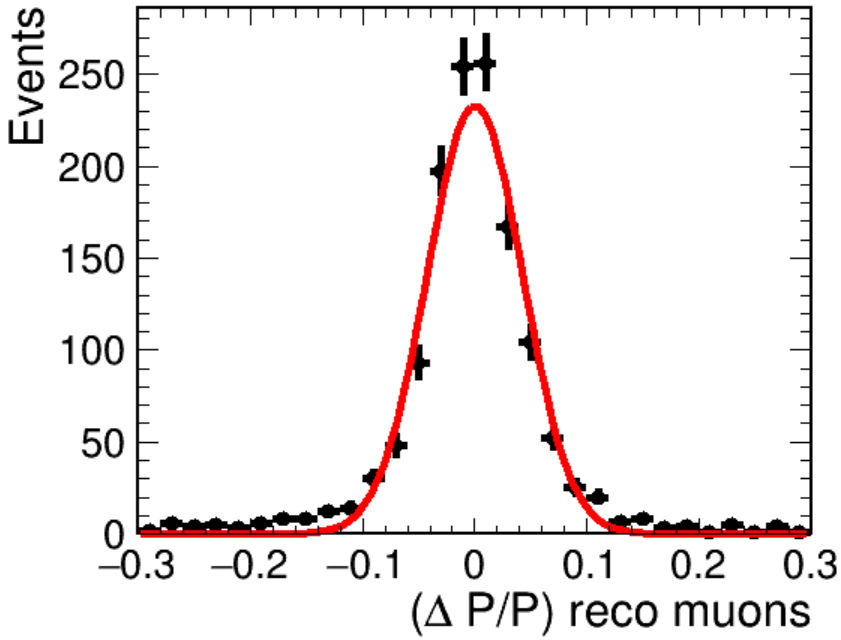
Efficiency should go to zero at KE=0.

Work in Progress – Optimizations will improve this

Tracking Performance: Muon Angles and Momenta

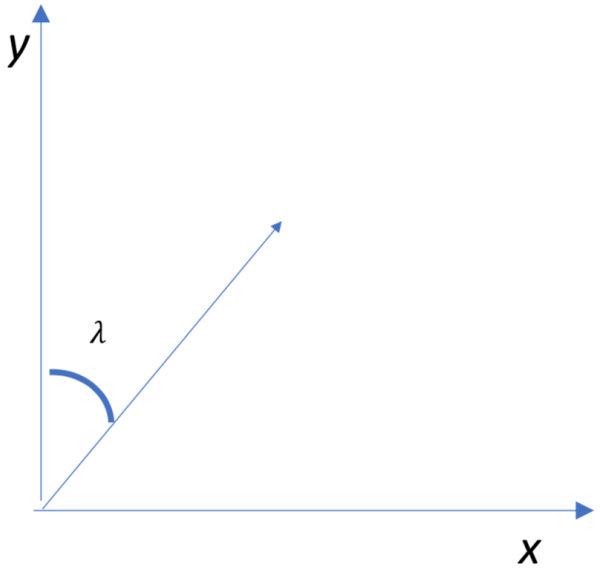
Work in Progress – Optimizations will improve these

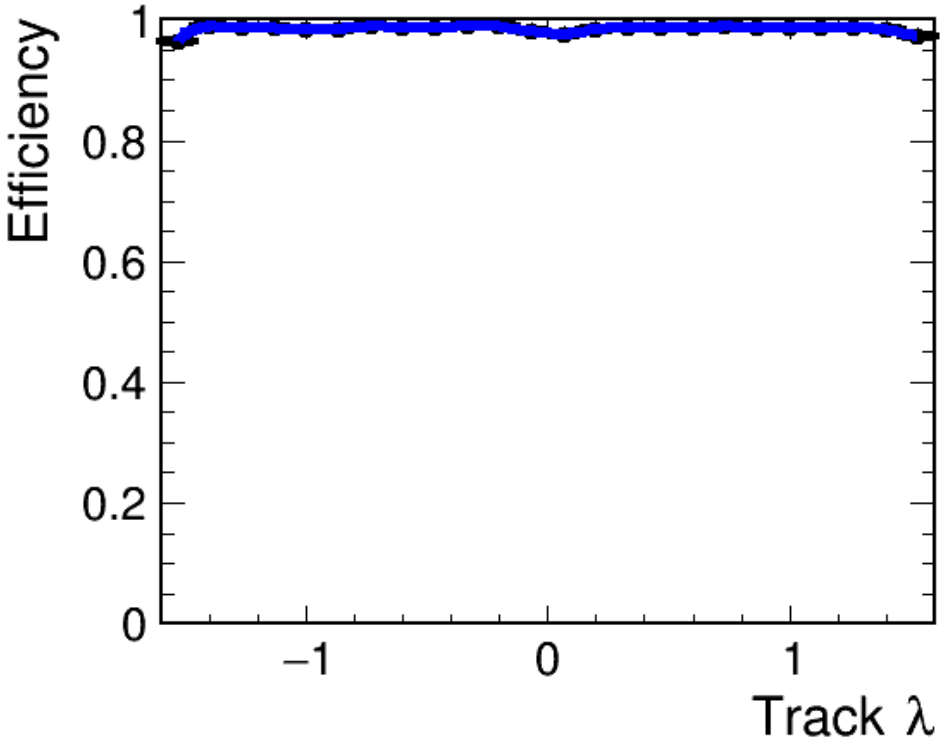




~1 Degree angular resolution, and ~4.2% momentum resolution

Tracking Performance: 4π Coverage

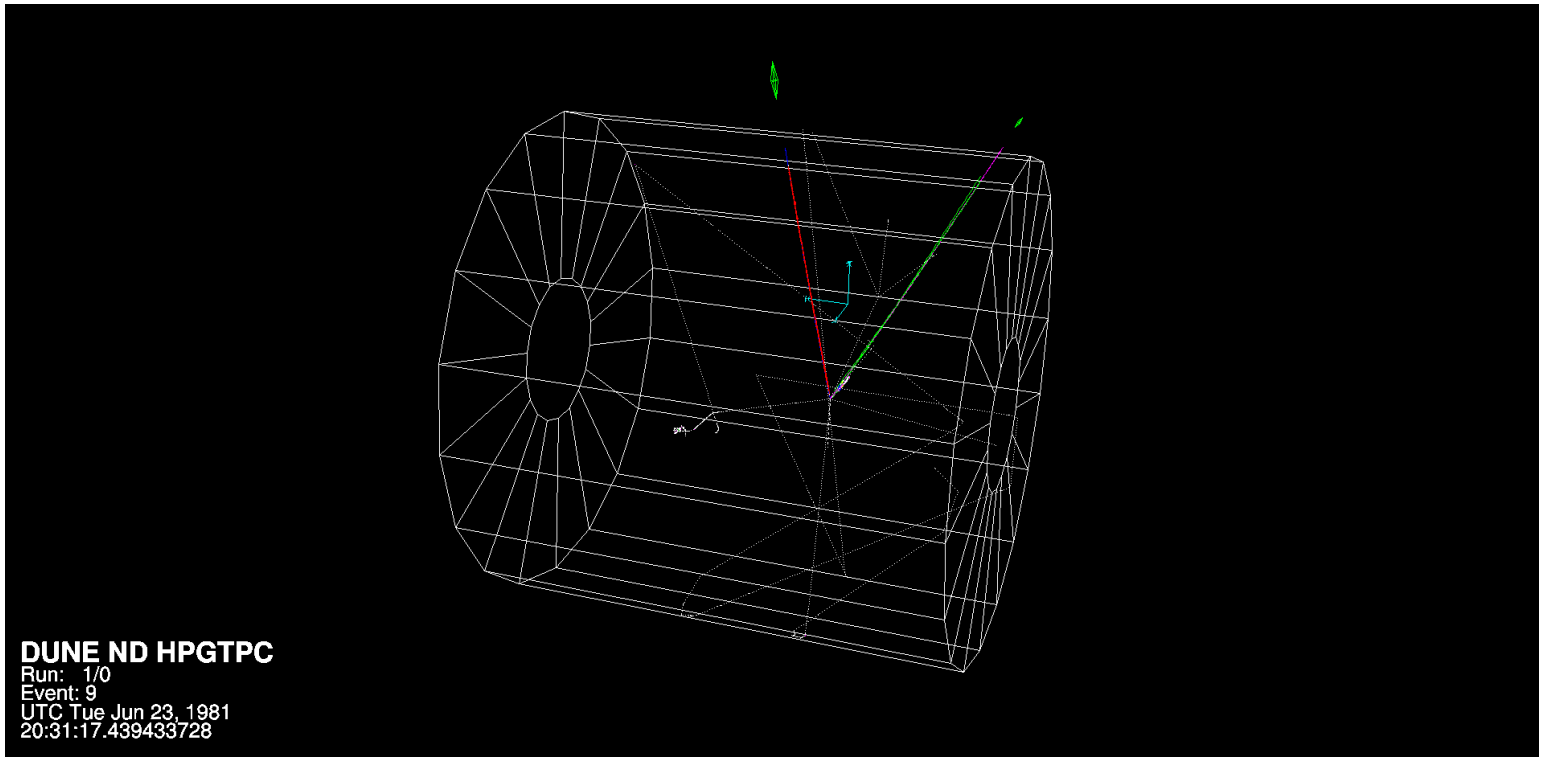




All tracks with momentum > 200 MeV/c (protons are inefficient for momenta below 150 MeV/c)

n.b. Charge modeling on the pads is naive – induced signals will be less for trains of charge arriving on the same pad over lengths of time

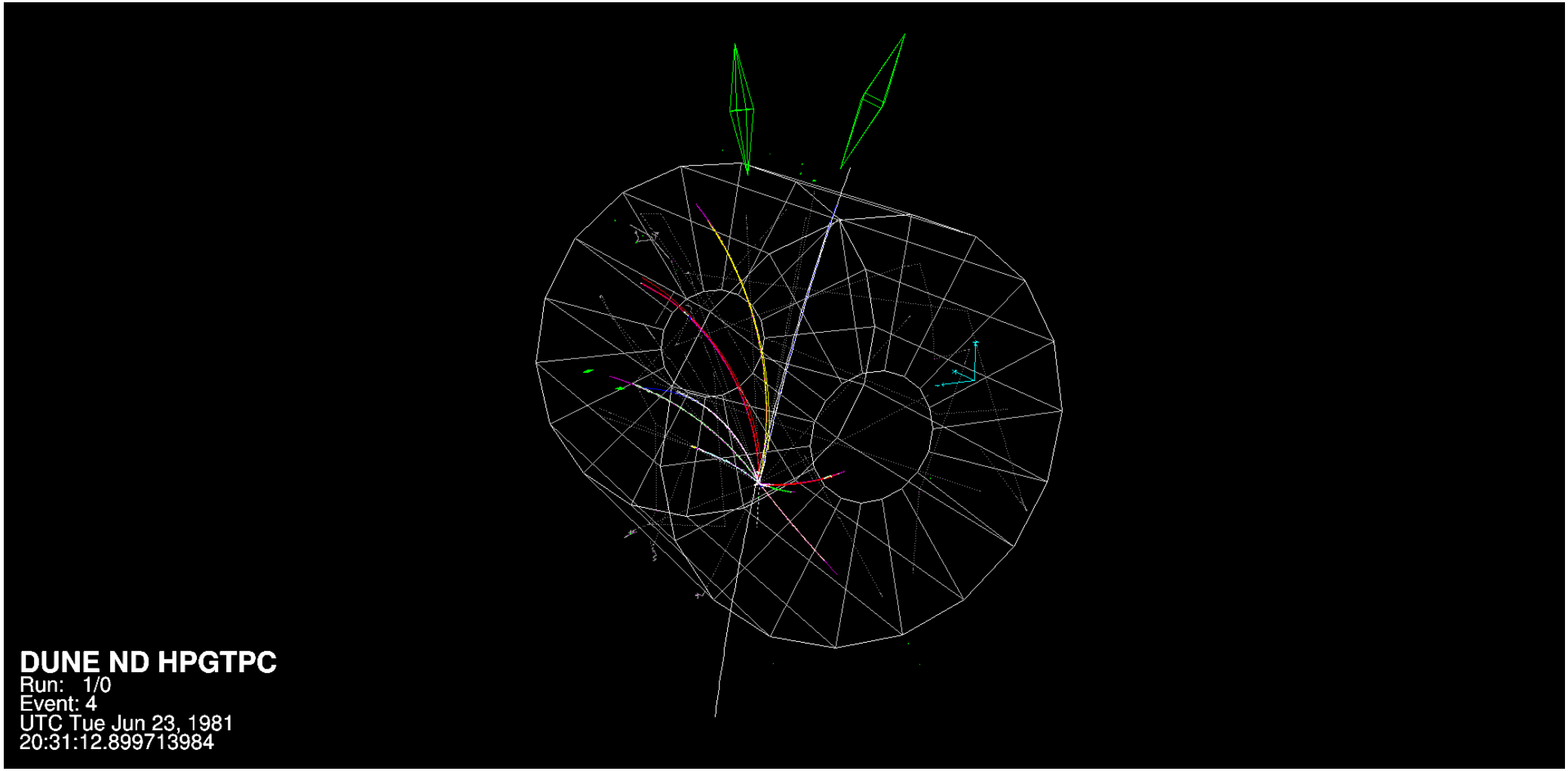
ECAL Clusters in the EVD



Octaheadron with length proportional to energy drawn. Cluster location at inside tip Octahedron oriented along cluster major axis (for pointing. Different from a collider detector's ECAL display where you can project back to the beamline)

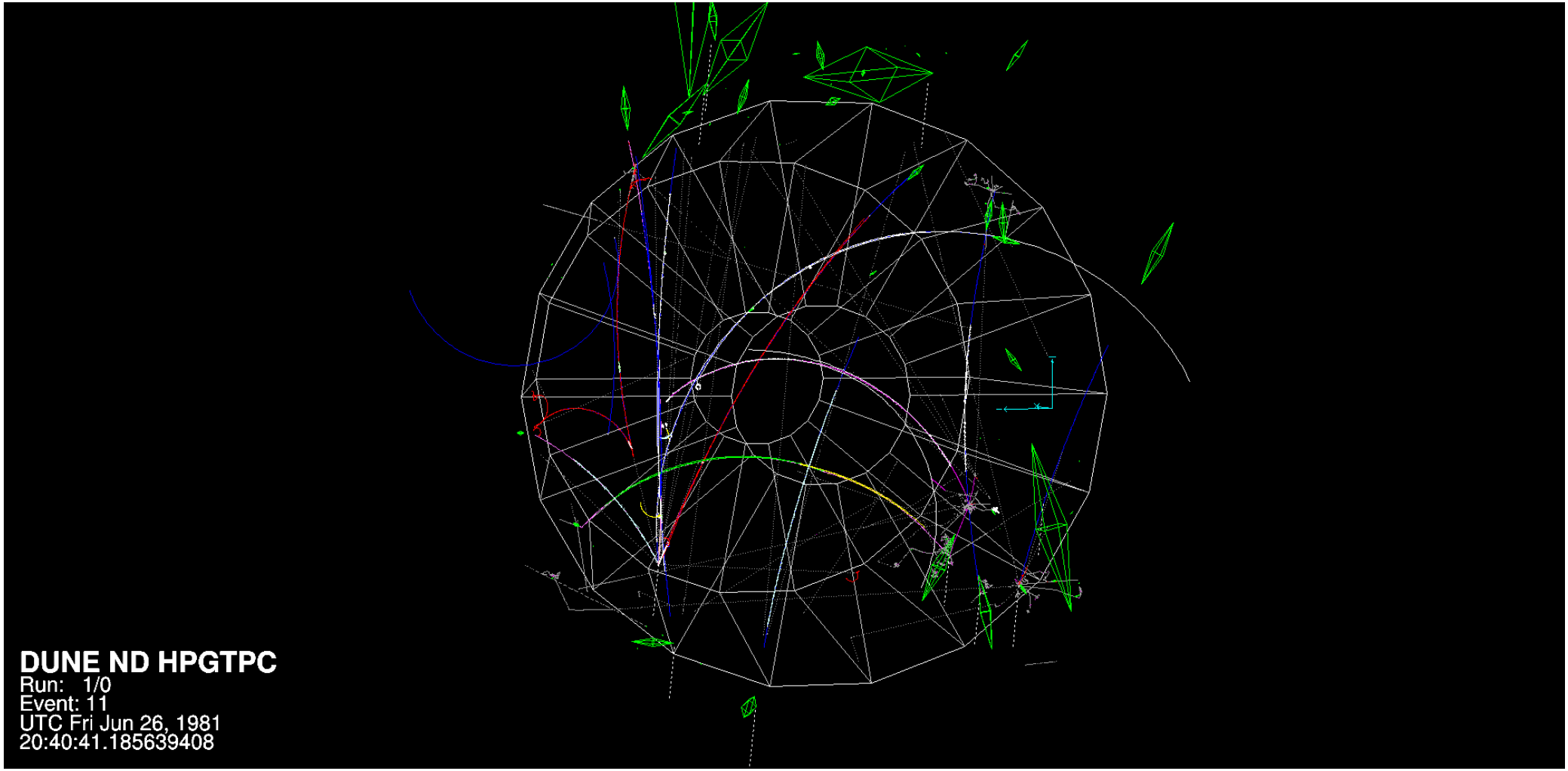
Red track is a muon (blue MC particle), Green track is a proton.

ECAL Clusters in the EVD



An GENIE event with some more activity

An event with 10 Interactions



About twice the pileup we expect on average. But well within the distribution.

Another 10-interaction Event