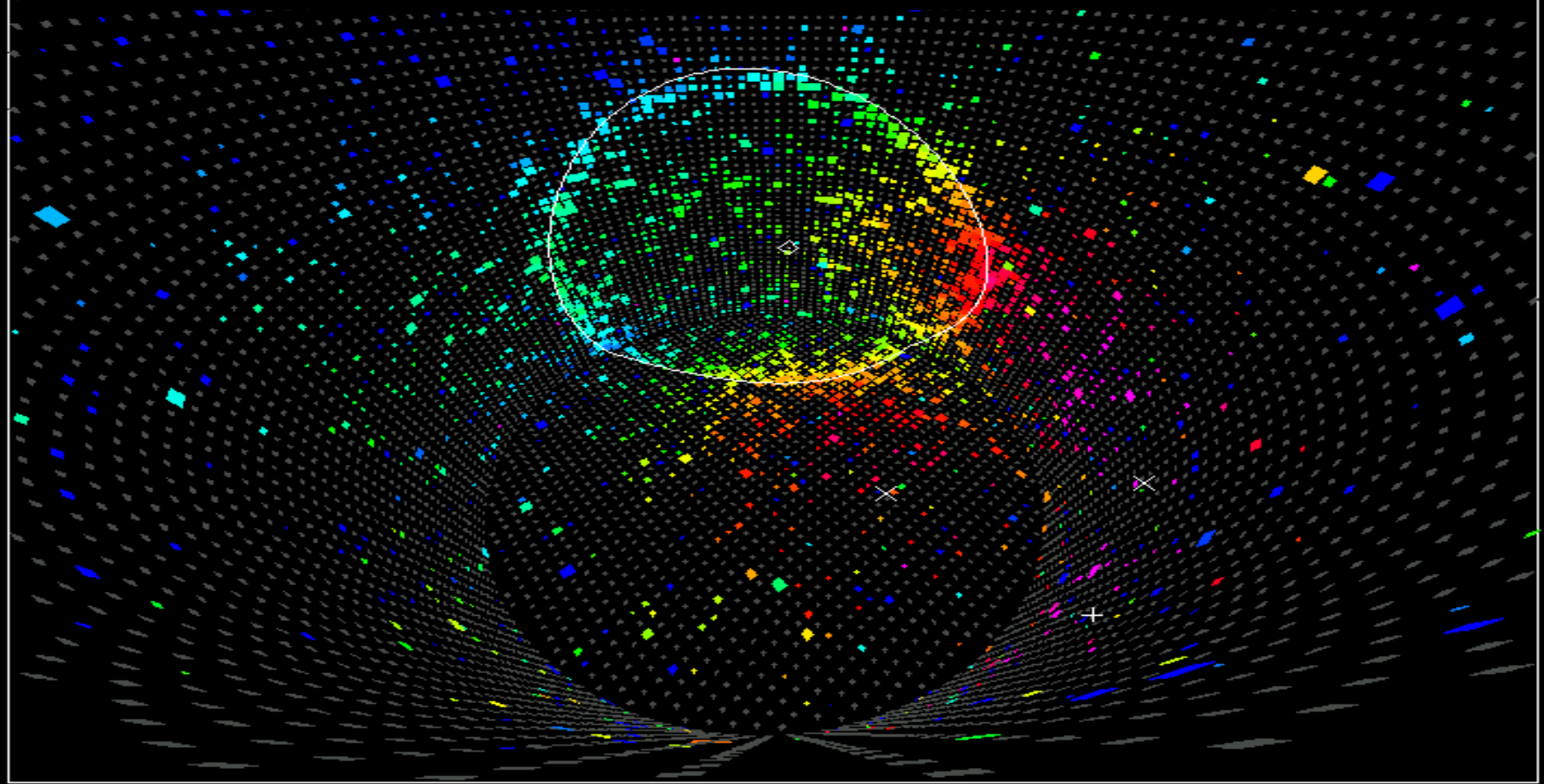
Development of a Versatile, Stand-Alone Tracker



Matthew Wetstein - Enrico Fermi Institute, University of Chicago
HEP Division, Argonne National Lab

Two Approaches to Building Reconstruction Algorithms

Start from an ideal detector →

make it worse to reflect real detector effects

- A chance to think about new analysis techniques.
- Flexible over large changes in detector design.
- Could guide development of new technological capabilities.

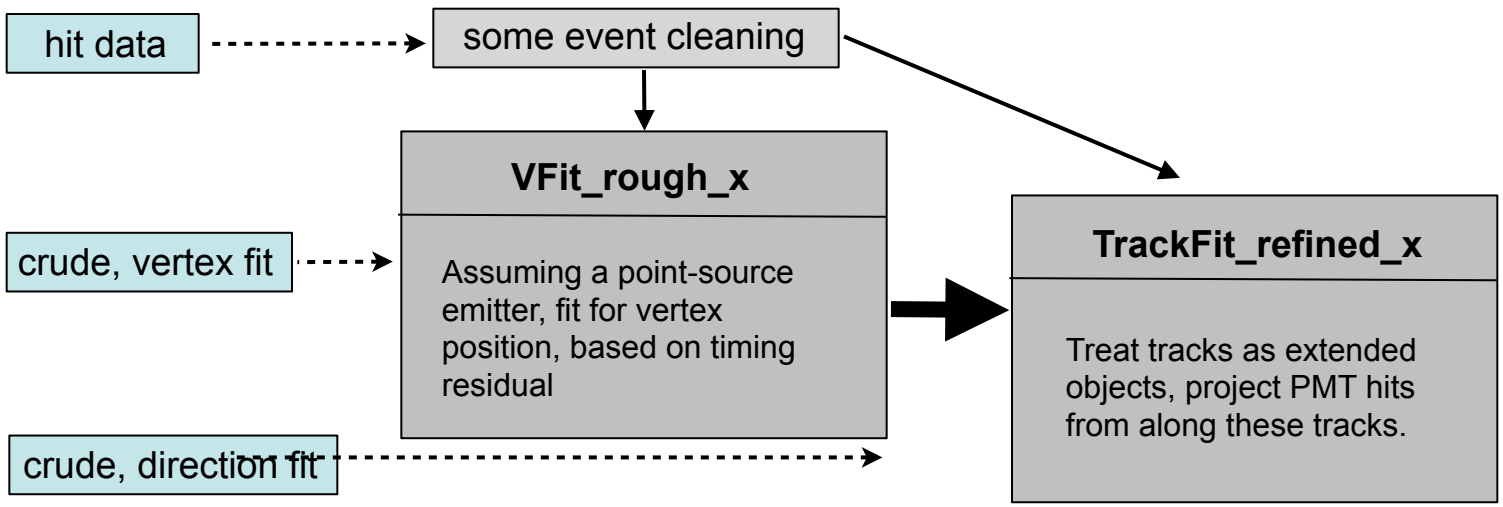
← Start from an existing detector

make it better to reflect detector improvements

- Built on a library of existing knowledge.
- Easy to adapt.
- An important cross-check on new analysis techniques.

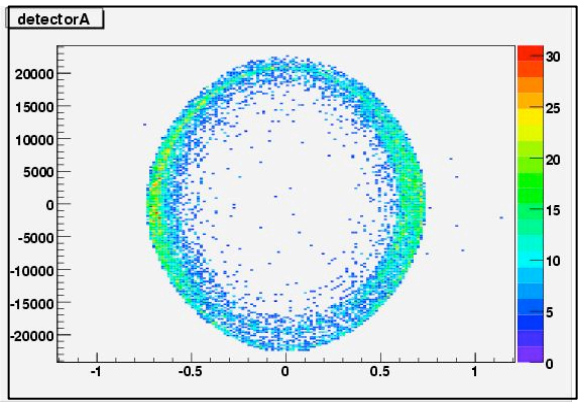
About TrackFitter

- Stand-alone track fitting software
  - reads flat, text, n-tuples of hit data
  - library of tracking and likelihood algorithms
  - MINUIT-based executables
- Currently capable of “point-like” and “track-like” vertex fitting, based on the timing residual between measured and extrapolated hit times.
- Built to eventually enable up to 7-parameter, simultaneous fits, and likelihoods built on several observables.



GEANT Model

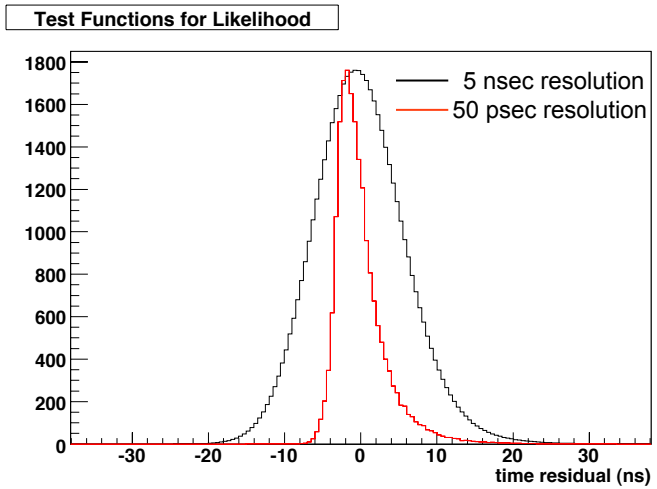
- Currently using a hacked version of WC Sim
  - simple barrel of water using WC sim physics
  - truth-level hits written to text
- This is good for initial calibration of fitter
- It is also good for quickly comparing variations in detector design - can change resolutions, granularity and coverage, a posteriori

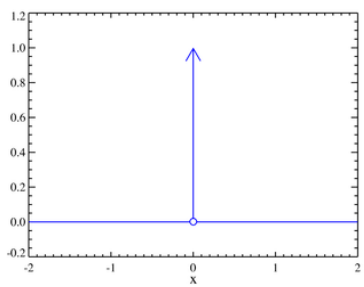


But, it is not the plan to stay this way. Next step is integrate with the full WCSim framework.

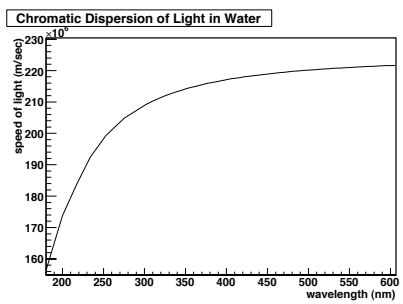
The Likelihood Test-Function

- Not necessarily symmetric (or analytic)
- At time resolutions below 1 ns, chromatic dispersion is significant
- Contains more shape information than just the width

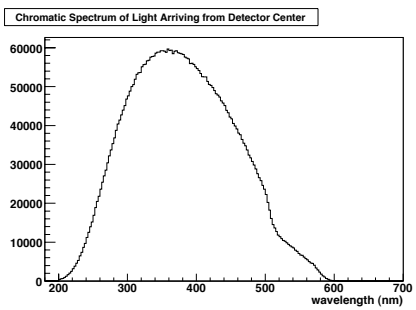


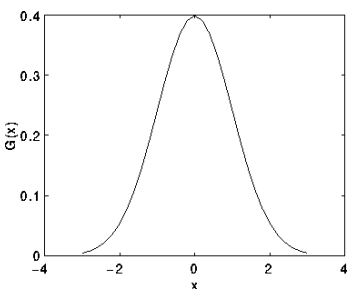


1. Start with a delta function to represent the time residual, corresponding to a fixed speed of light



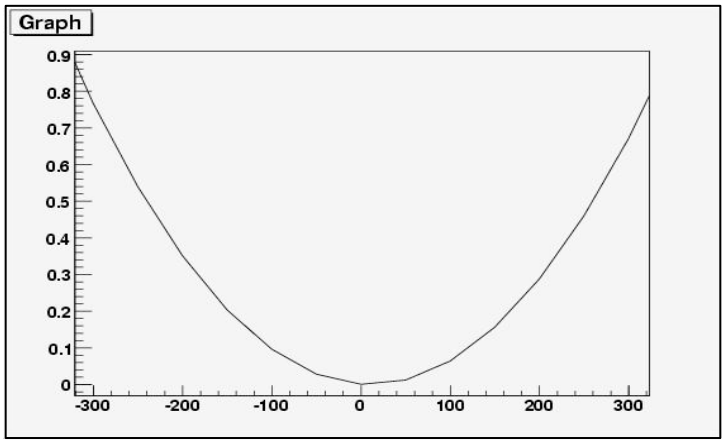
2. Recalculate and sum the delta function at times corresponding to different speeds of light, weighted by the chromatic spectrum. One must use the hit positions and their distances from a hypothesized track.

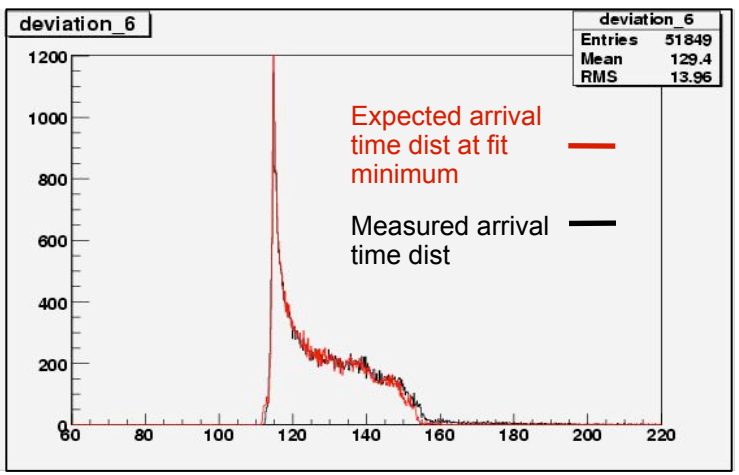


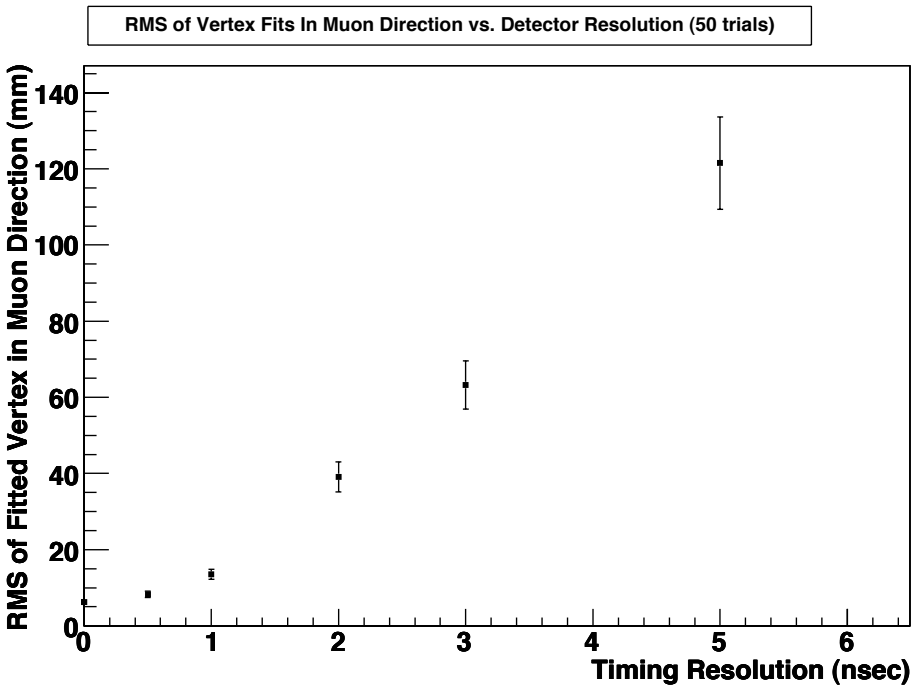


3. Convolute with a gaussian resolution term.

Initial Results - Point-like Fit

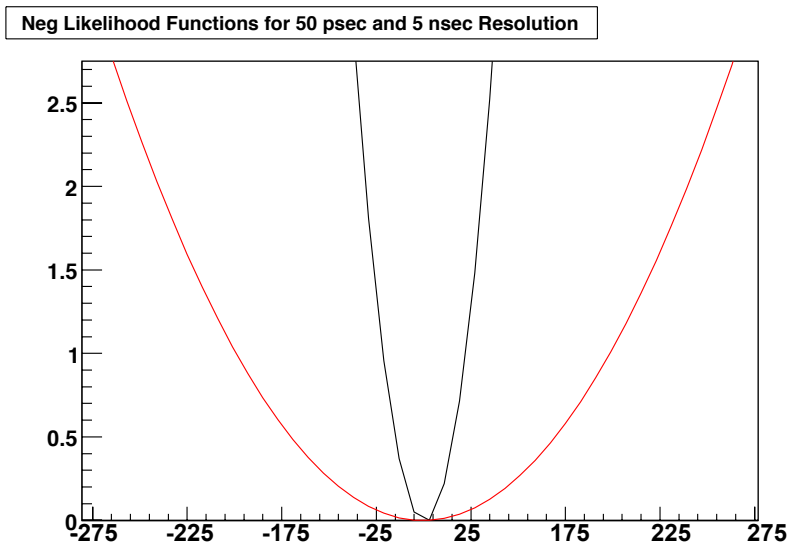


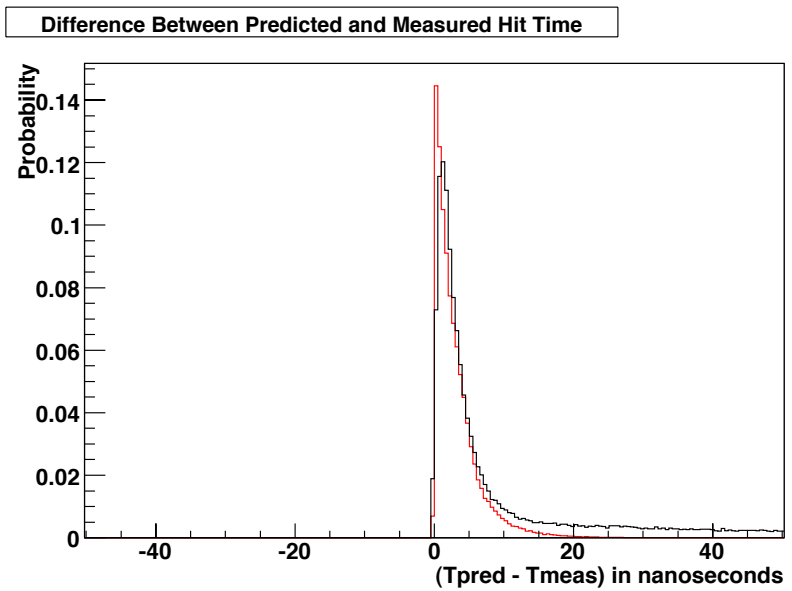




- No chromatic dispersion
- straight muon trajectory
- 100% coverage
- For proof of principals

Initial Results - Track-like Fit





These test fits, assume knowledge of T_0

- T_0 is degenerate with vertex position in the direction along the track.
- Next series of fits will use time residual only
- But, they still retain the advantage of incorporating more detailed shaped information in time-residual distribution than in past likelihood approaches
- Event though, T_0 of a single vertex is unknown we are more interested in the difference in T_0 for two vertices.

Next Steps

- Comparison of point-like and track-like fits from WCSim data to other vertexing code, being developed by the collaboration.
- Make TrackFitter publicly available (code comments, neatening up)
- Better event cleaning (or integrate with existing selection code)
- Adding more capabilities:
  - crude, first-order vertexing based on hit positions
  - direction fitting, based on light within cone