Very Short Decays

(Work in Progress)

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Goal

- Understand expected yield of “Very Short Decays”
  - Tau (or charm) events where the daughter tracks are included in the primary vertex track assignment – “mixed” vertex
- Develop code for splitting the primary vertex into primary + 2ndry vertex

MC Simulation

- Generated 500 CC Tau events with standard branching ratios
  - Generate m-files containing GEANT truth information
    - Particle code, ITRA (Geant track number) and STID (2ndry track ID) are encoded in the segment pulseheight word
  - Tau decay mode determined by get_tau_truth
    - 10% Short decay (daughter track IP > 10 micron to Primary vtx)
    - 75% LL decay
    - 0% LS decay (not simulated)
    - 7% Tau leaves scan volume or daughter tracks not found
    - 2% Daughter tracks mixed with Primary (IP < 3 micron)
    - 6% Daughter tracks mixed with Primary (IP > 3 micron)

Goal of this study

Vertex Fitting

- Splitting a vertex requires a good understanding of the track fitting errors and momentum
- Long emulsion tracks
  - Data: Use MCS momentum (Komatsu) or spectrometer momentum fit
  - MC: Use True momentum if no spectrometer momentum fit and nseg > 5
  - Multiple scattering $\theta ms = 0.003/momentum$
    - Error expected for 1 GeV track in 1 mm Fe
- Short emulsion tracks or momentum not known
  - Multiple scattering $\theta ms = 0.012/nseg$
  - Track angle (θ) dependent plate resolution
  - $\sigma^2 = (\text{plate resolution} * (1 + 10 * \theta))^2 + (\delta z * \theta ms)^2$
- First 3 segments of track are fit
  - Error matrix passed to the vertex fitter

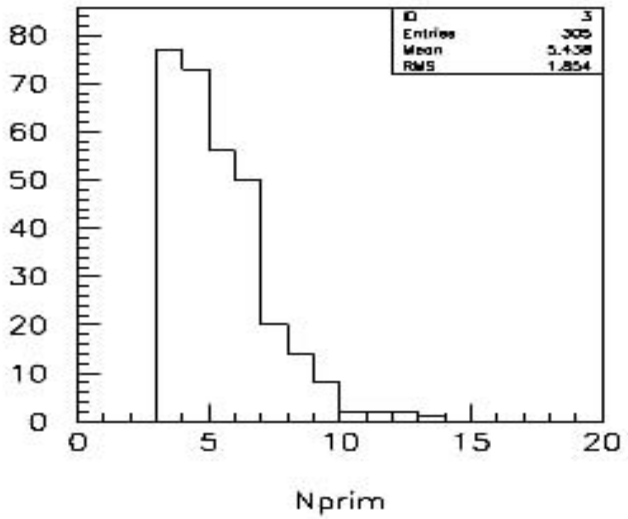
Need to check

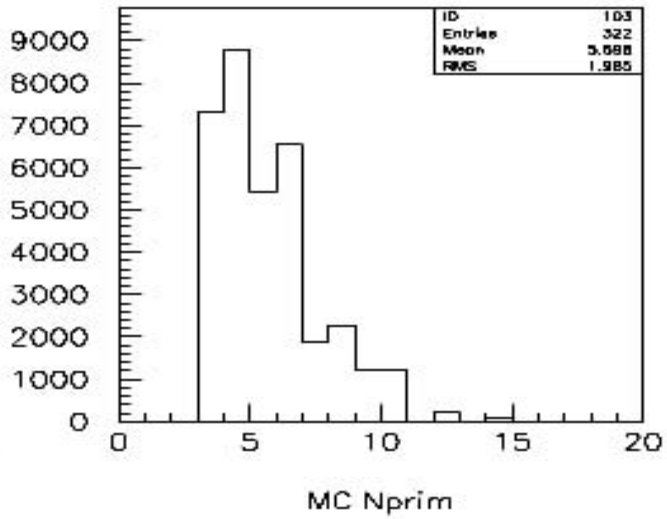
Vertex Fitting & Splitting

- Remove 1 segment tracks from the primary
  - Error matrix not defined
- Require > 2 long primary tracks
- Results from vtxfit
  - Vtx position, vertex χ^2, vertex track χ^2, track IP
- Compare standard MC and Phase 1 & 2
  - Standard MC contains CCmu, CCe, CCtau, NC

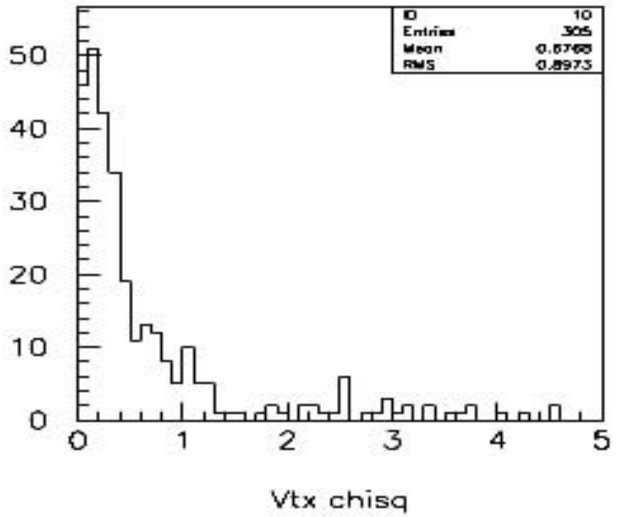
Data

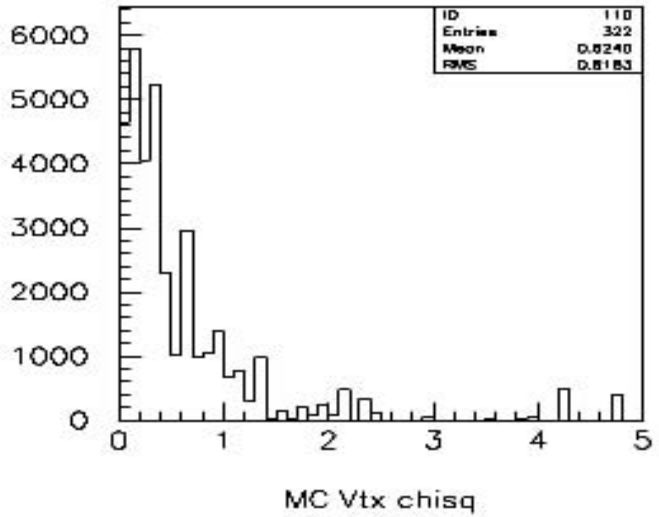
MC - Std





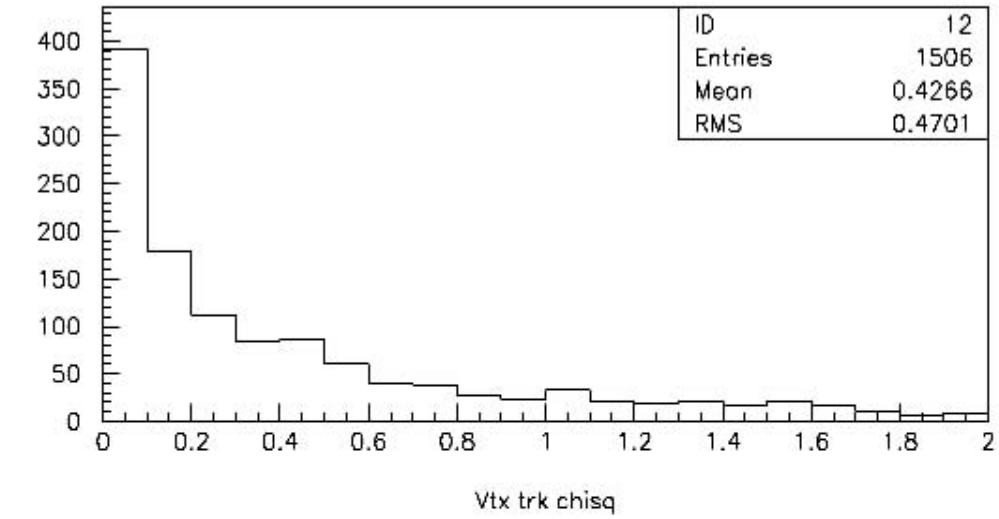
Number of primary trks





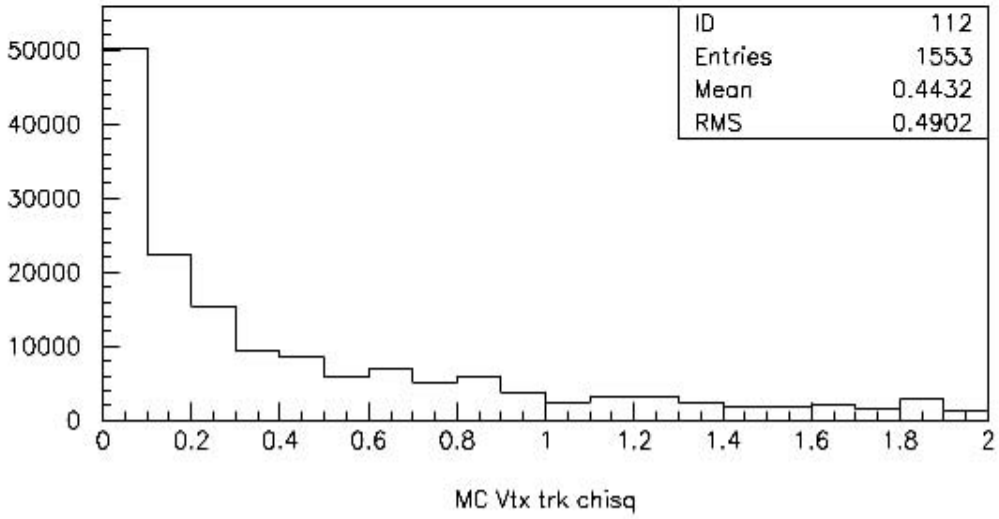
Vertex χ^2

Vertex track χ^2



Data

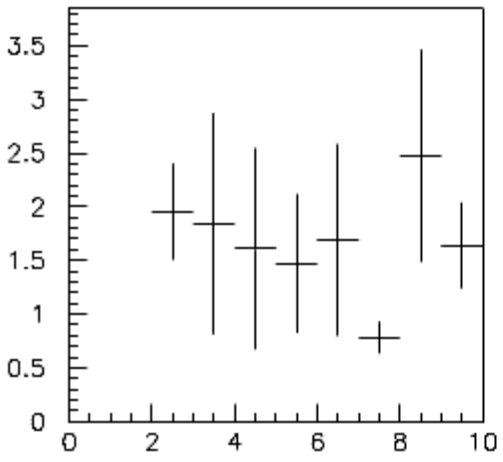
Track fit weighting scheme is OK in a general sense

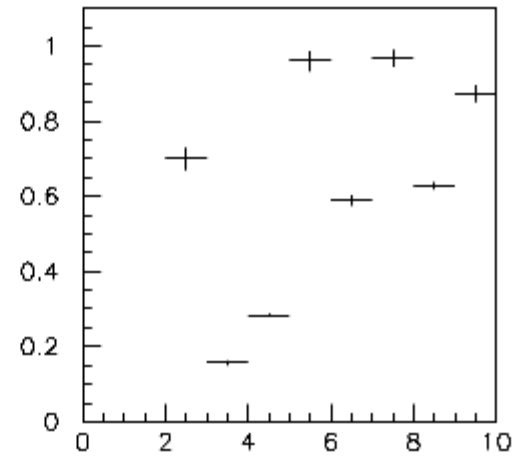


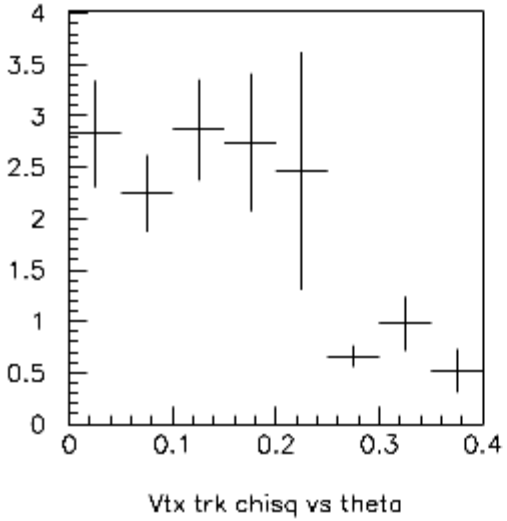
MC

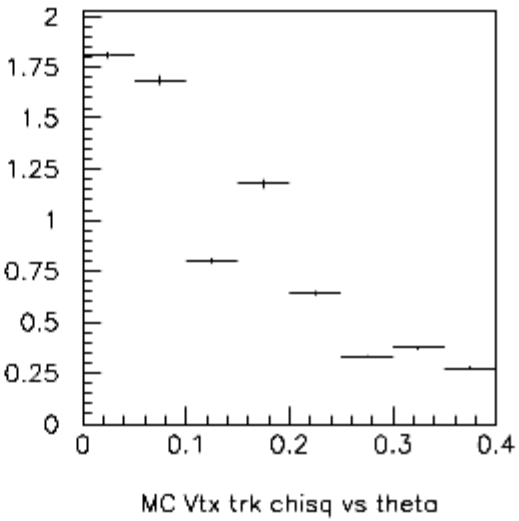
Data

MC - Std







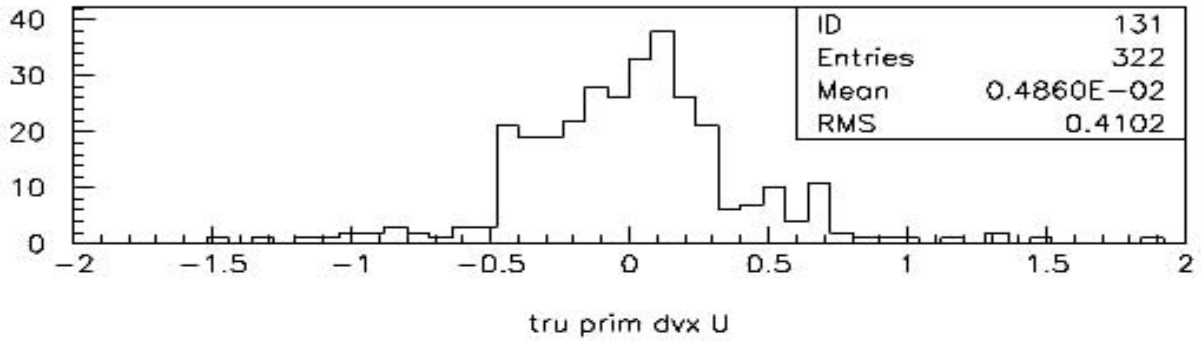


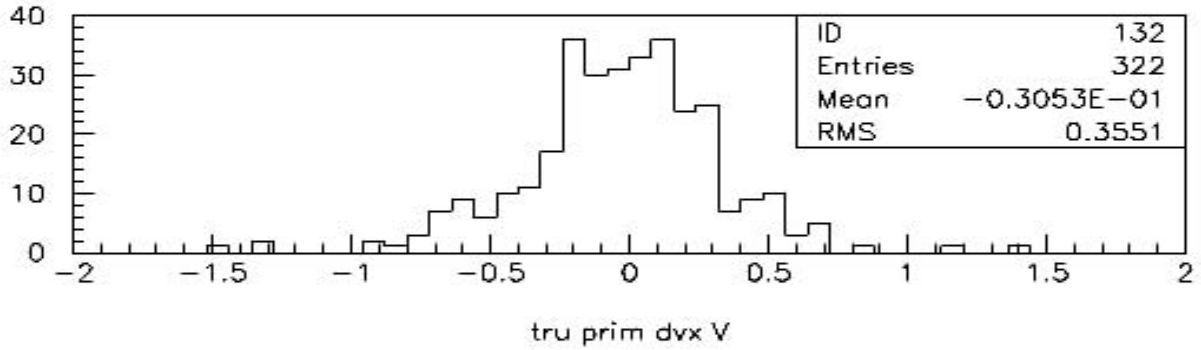
Number of segments

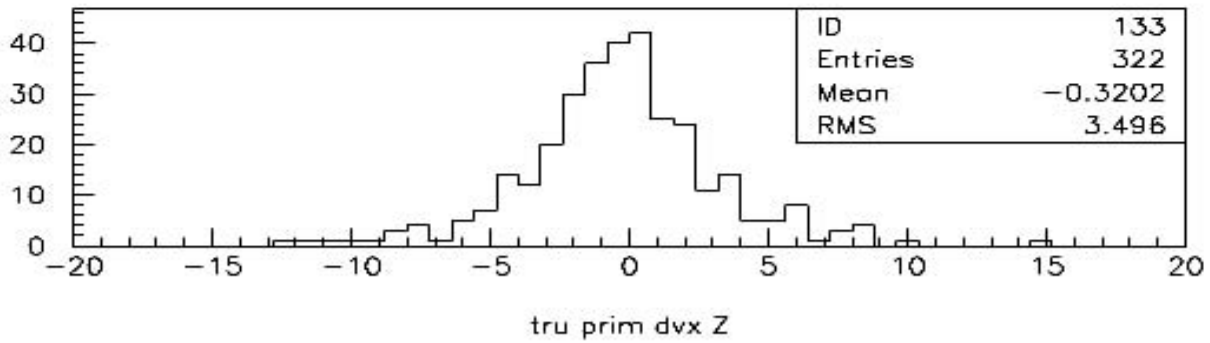
Vtx Trk χ^2 higher in Data than MC but Vtx χ^2 is about the same…

Track angle

Plate resolution is independent of θ in the MC





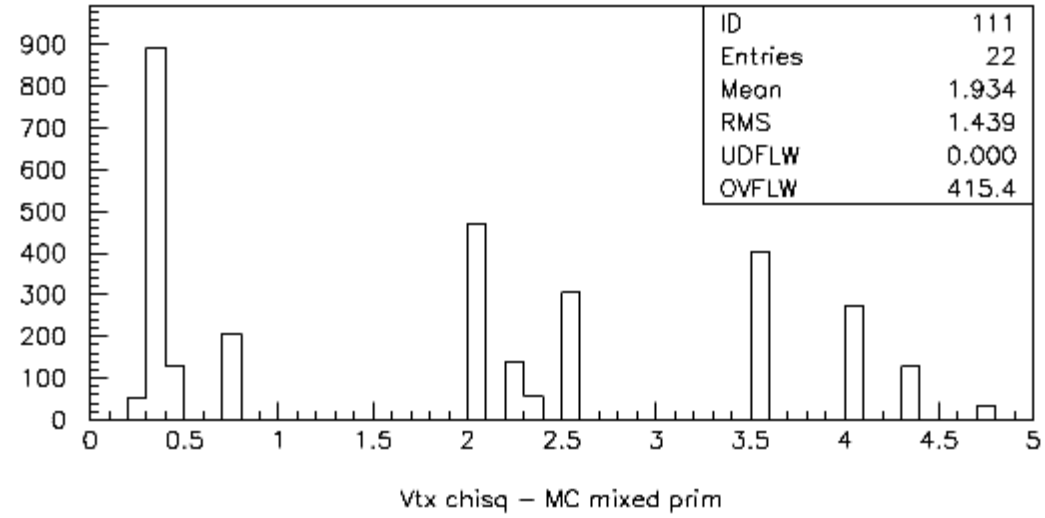


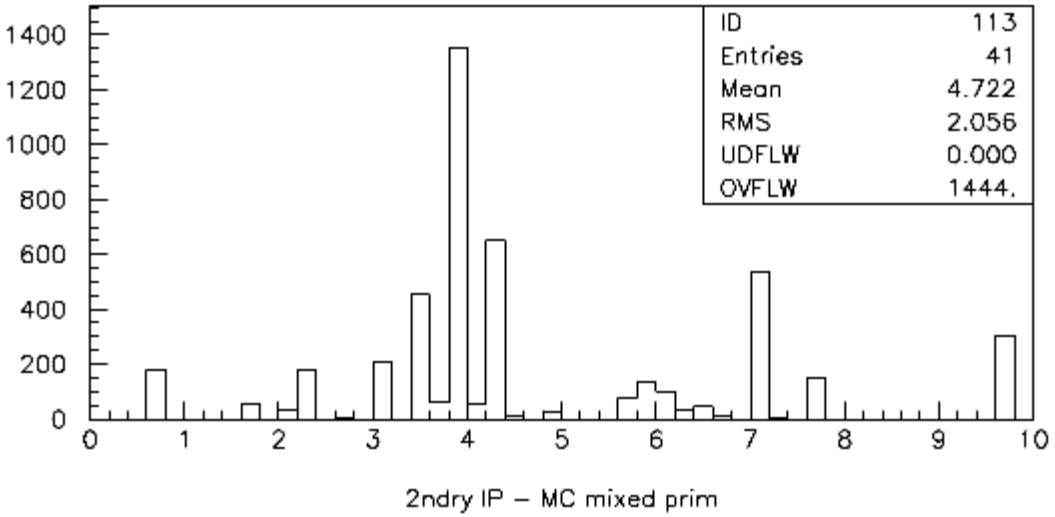
MC - Std

Error between fit and true vertex position (μm)

$\sigma_{u,v} \sim .35$ μm

$\sigma_z \sim 3.5$ μm



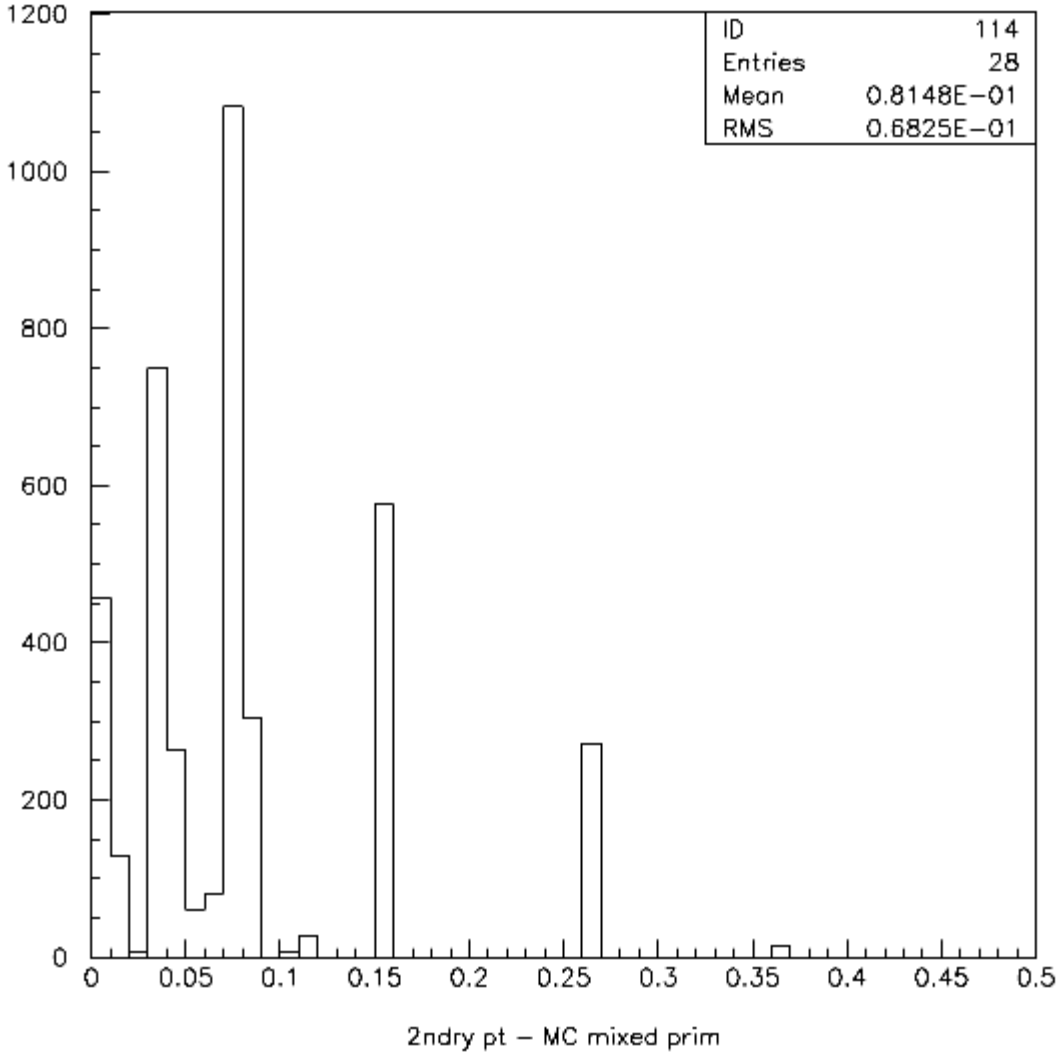


CC Tau MC

Tau daughter tracks mixed with primary vertex tracks (IP > 3 μm)

Vertex $\chi^2 > 1.5$ is a reasonable cut

42/415 Data evts



CC Tau MC

Calculate min pt

Flight to first emulsion plate is too long

Identifying kink decays unlikely with these cuts

Very Short Trident Search?

- 6% of tau decays have at least one daughter with IP > 3 micron to the primary vertex
  - 64% of tau decays have one daughter with IP > 3 micron
  - 36% of tau decays have > 1 daughter with IP > 3 micron
    - ~2% of tau decays will have very short tridents