Statistical Analysis of 4 events

1. Reject hypothesis that events are all scatter or charm

   .019 events expected → rejected to 95%

2. Show consistency of events with ν_τ hypothesis
   - Expected number of events assuming ν_τ hypothesis

     3.5 expected

   - Is each individual event consistent with MC ν_τ events?

3024_30175	.225
3039_01910	.487
3263_25102	.061
3333_17665	.656

   - For each event show Prob.(ν_τ) [vs. Prob.(**not** ν_τ)]

3024_30175	.813
3039_01910	.971
3263_25102	.327
3333_17665	.977

Rejection of scatter and charm hypothesis

Rejection of scatter & charm hypothesis:

1. Define an *acceptance interval* in parameter space for τ events using multidimensional histograms of simulated tau events. This will be a combination of "tau" evaluation and cuts on p_t , primary angle and decay length.
2. Calculate number of charm and scatter events expected within that interval using MC generated events → normalize to data set of 203
3. Use a Poisson distribution (with expectation value equal to the number of expected charm and scatter events) and number of observed events to see with what confidence the hypothesis can be rejected.

$.15 + .022 + .016 = .19$ expected $\quad P_{poisson}(4, .19) = 9.5\ 10^{-7}$

→ 4 found : rejected > 95%

Acceptance interval

Acceptance interval criteria:

1. At least 1 segment parent
2. .05 of MC ν_τ events less likely (parameter analysis)
3. $p_t > 250$ MeV
4. Primary angle < .200 wrt. neutrino
5. Decay length < .5cm

Asside:

Fraction of ν_τ events in acceptance interval :

1 → .85 single charge decay * .75 single segment parent

(properties of MC data set ;only single charge decays and decays with visible parent are in data set.)

2-5 → .632 (fraction of MC data set events satisfying criteria 2-5)

$\Pi_{1\text{-}5} = .403$

Expected number of charm events

	e cc	μ p cc	μ np cc
Data set size	203	203	203
Fraction of interactions	.30	.27	.16
Faction of interactions producing charm, single charge decay, single segment, trigger, lost e or μ	$8.84 \cdot 10^{-3}$ .25	$1.93 \cdot 10^{-3}$	$1.75 \cdot 10^{-3}$
Fraction in acceptance interval	.49	.54	.47
Π	.067	.057	.026

Σ = .15

Expected number of scatter events: CC

	e cc	μ p cc	μ np cc
Data set size	203	203	203
Fraction of interaction	.30	.27	.16
Faction of interactions with lepton lost & trigger	.25 .92	.22	.45
Average number of scatters in event (within 5mm)	1.82	1.85	1.97
Fraction in acceptance interval	$2.9\ 10^{-4}$	$1.3\ 10^{-4}$	$3.2\ 10^{-4}$
Π	$7.4\ 10^{-3}$	$5.4\ 10^{-3}$	9.2 10

$\Sigma = .022$

Expected number of scatter events : NC

	e cc	μ p cc	μ np cc
Data set size	203	203	203
Fraction of interaction	.090	.083	.048
Faction of interactions with lepton lost & trigger	.73	.77	.60
Average number of scatters in event (within 5mm)	2.07	2.05	2.17
Fraction in acceptance interval	$3.1 \; 10^{-4}$	$1.9 \; 10^{-4}$	$1.9 \; 10^{-4}$
Π	$8.6 \; 10^{-3}$	$5.1 \; 10^{-3}$	$2.4 \; 10^{-3}$

$\Sigma = .016$

Tau hypothesis: expected number of events

Tau hypothesis:

Is four events consistent with a tau hypothesis?

Hypothesis is that 4.2% of interactions are due to tau.

(from RS thesis: # ν_τ cc / #$\nu_\mu$cc = .152 , #$\nu_\mu$cc = #$\nu_e$cc …)

Data set size	203	
Fraction of all interactions ν_τ	.042	
Fraction of ν_τ interactions in		
MC data set (.85 C1 *.75 sing.seg.)	.637	
acceptance interval	.632	Π = 3.45

The 90% confidence limit of a Poisson distribution with expectation value of 3.45 is [1.0, 8.2]

$\rightarrow$ 4 consistent

Tau hypothesis: individual event consistency

Within tau hypothesis:

Are individual events consistent with MC ν_τ event distributions ?

- Using multidimensional histograms, one can find the fraction of ν_τ events that are less likely than one with the measured set of parameters.
- This fraction is the sum of all bins which have a lower weighted population than does the bin corresponding to the event in question

a.k.a. "parameter analysis: tau evaluation"

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All events are possible ν_τ interactions

Tau hypothesis: probabilities

Within tau hypothesis: Individual event probabilities.

- Hypothesis is that events are either ν_τ, charm or scatters. The probability that an individual event is a ν_τ interactions vs. all other possibilities can be calculated.
- Using multidimensional histograms normalized to unit area as PDFs, $h_i(i|\text{event})$ and (normalizations * rate) as prior probabilities a_i , the probability that an event is of type j is given by

$$P(\text{event}|j) = \frac{a_{j*} h_j(j|\text{event})}{\Sigma\, a_{i*} h_i(i|\text{event})}$$

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