Four Parameter Analysis on the Trident Events
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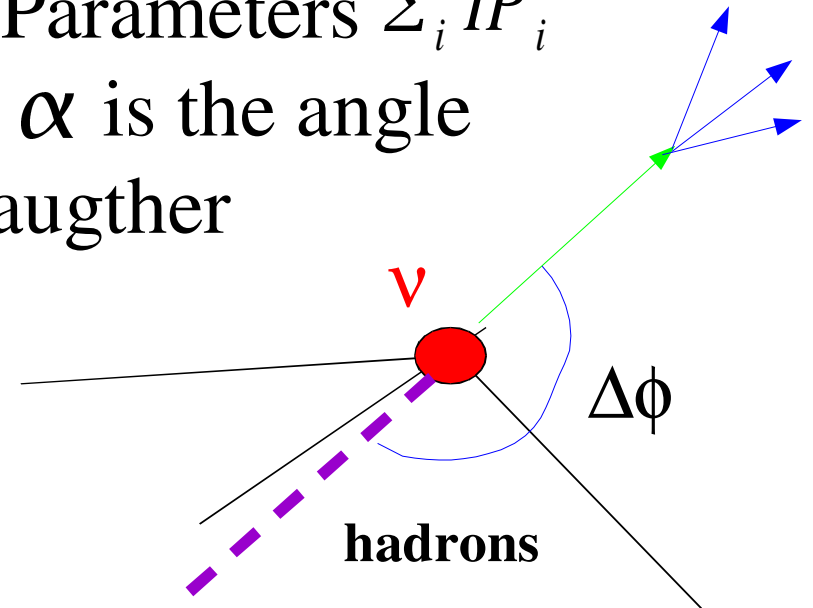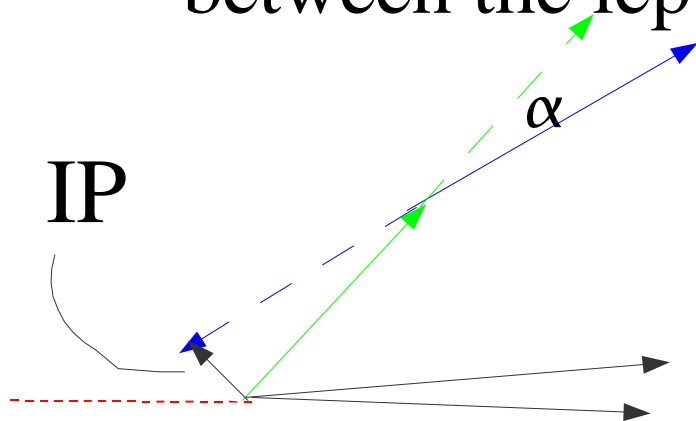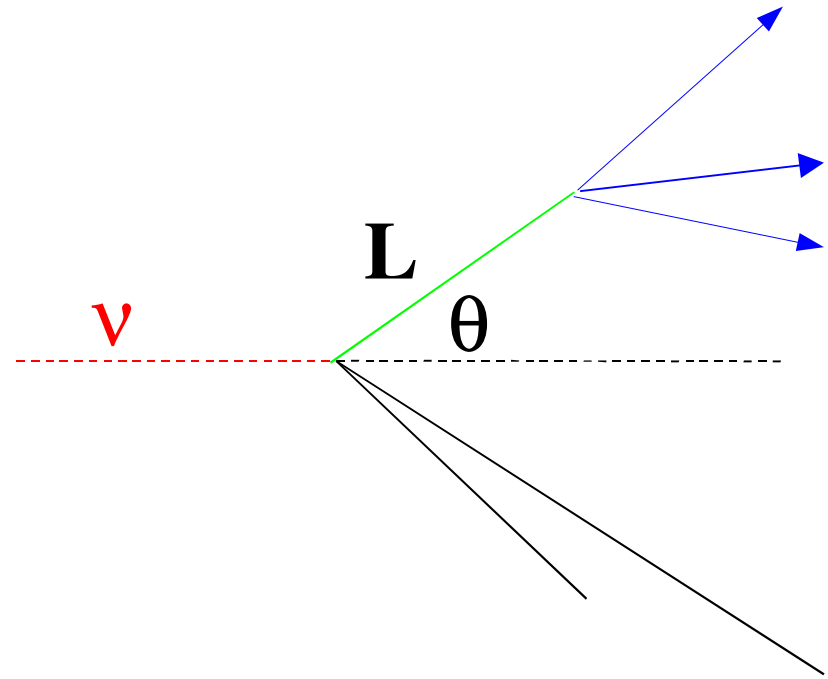## DONuT Collaboration Mtg.
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Parameters

- Production Angle θ

- Angular Symmetry $\Delta\phi$

- Decay Length L

- Sum of the Daughter Impact Parameters $\Sigma_i IP_i$ $i=1,2,3$, $IP = L\sin\alpha$ where α is the angle between the lepton and the daugther

Old vs. New Data Sets

Number of Simulated Events

Old Data Set (Three Parameters)

- Tau – 470,963
- Charm – 391,986
- Interactions – 445,700

New Data Set (Four Parameters)

- Tau – 188,000
- Charm – 172,000
- Interactions – 151,000

Distributions similar for all 3 parameters

Individual Event Probabilities

$$P(x\ event_i) = \frac{A_i * PDF_i(x)}{\Sigma_J A_j * PDF_j(x)}$$

P = The probability of a set of observables, x, being a result of event i, where $i \in (\nu_\tau\ cc, charm, hadronic\ scatter)$.

Two inputs for each event type:

1. A$_i$ <u>prior probability</u>:

        Knowledge of the likelihood of each event i

        Relative Normalization (aka   N$_{signal,}$ N$_{charm\ bkg,}$ N$_{int.\ bkg}$),

2. PDF$_i$(x): <u>probability density function</u>

        Probability of finding event in $(x, x+\Delta x)$

        where x is a 3- (for trident events) or 5- (for single prong events) tuple of parameters specific to the individual event

Three Parameters (as a check)

NOTE: Since both of these events are in the plastic, the prior probability of interacton is 0.00

Old Data Sets

Event	Tau	Charm	Int.
3334_19920	0.97	0.03	0.00
3296_18816	0.99	0.01	0.00

New Data Sets

Event	Tau	Charm	Int.
3334_19920	0.96	0.04	0.00
3296_18816	0.99	0.01	0.00

Using the new data sets:

Three Parameters

Event	Tau	Charm	Int.
3334_19920	0.96	0.04	0.00
3296_18816	0.99	0.01	0.00

Four Parameters

Event	Tau	Charm	Int.
3334_19920	0.99	0.01	0.00
3296_18816	0.85	0.15	0.00

All Results

3-Prong	Tau	Charm	Int.
3334_19920	0.96	0.04	0.00
3296_18816	0.99	0.01	0.00
1-Prong			
3024_19920	0.69	0.31	0.00
3039_01910	0.98	0.02	0.00
3263_25102	0.16	0.14	0.70
3333_17665	0.99	0.01	0.00

Conclusion

Both events are most likely tau events according to the four parameter analysis.

The four parameter analysis:

- Increases the probability that 3334_19920 is a tau event

- Decreases the probability that 3296_18816 is a tau event