Parameter Analysis of Charm Events

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  - With Lepton From Priamry
- Results for Single Kink Events
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- Prior Probabilities for Charm Trident Events
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- Results for Charm trident Event - 3245_22786
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- Conclusions

Prior Probabilities for Single Prong

Without a lepton from primary vertex:

- Tau Prior:

  $PP_\tau =< N_\tau > BR(\tau \rightarrow$ single prong)

- Charm Prior without lepton from primary: $PP_{charm} = \sum_i < N_{charm_i} > BR(charm_i \rightarrow$ single prong) $P_{\text{lost lepton}}$

- Interaction Prior without lepton from primary:

  $PP_{int} = \sum_i L_i P(\text{single prong}) P_{\text{lost lepton}}$

Prior Probability for Single Kink Charm Events with a Lepton from the Primary Vertex

- Tau Prior with lepton from primary:

  $PP_{\tau} = 0.00$

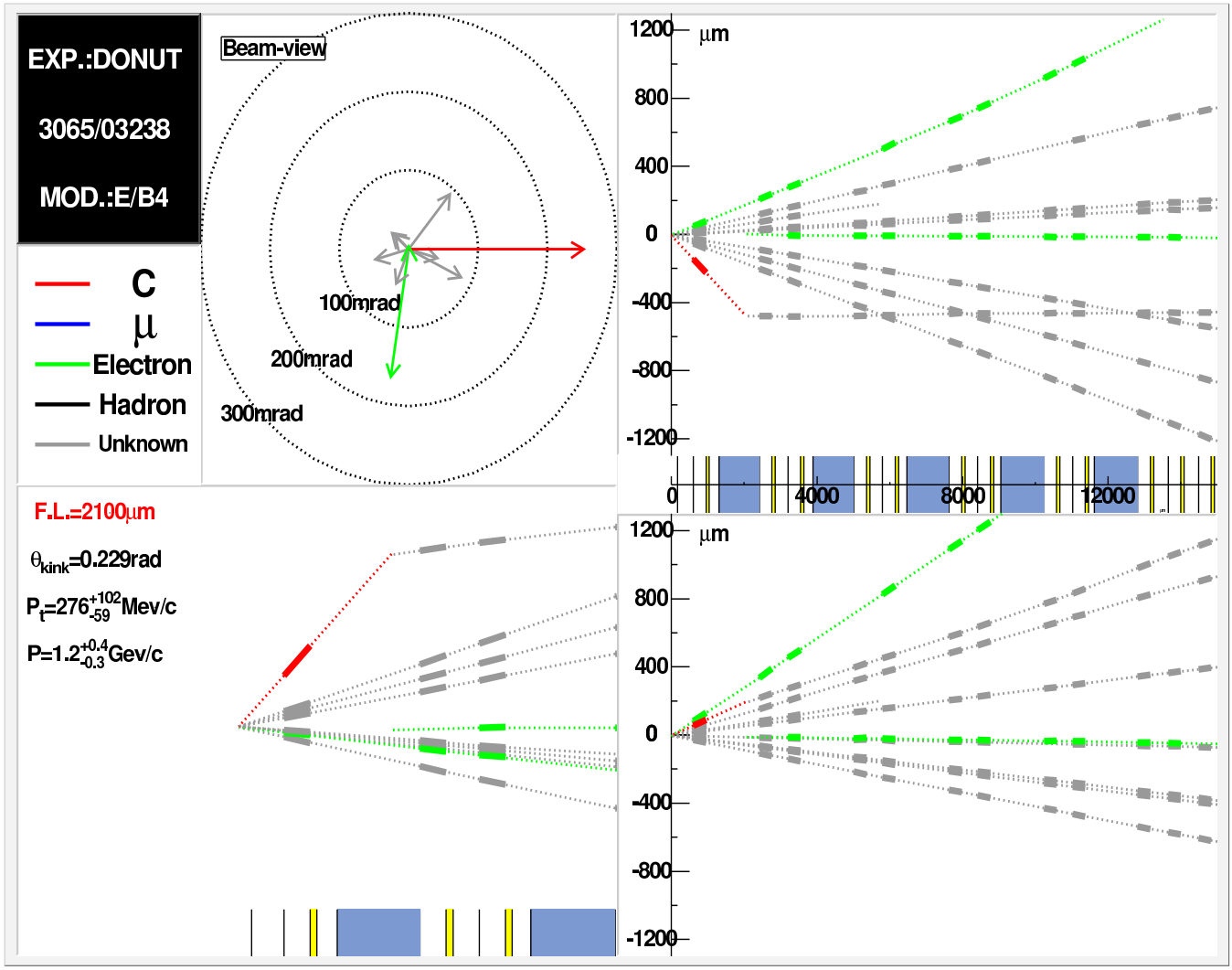
- Charm Prior with lepton from primary:

  $PP_{charm} = \sum_i < N_{charm_i} > BR(charm_i \rightarrow$ single prong)

- Interaction Prior with lepton from primary:

  $PP_{int} = \sum_i L_i P$(single prong)

Event 3065_03238



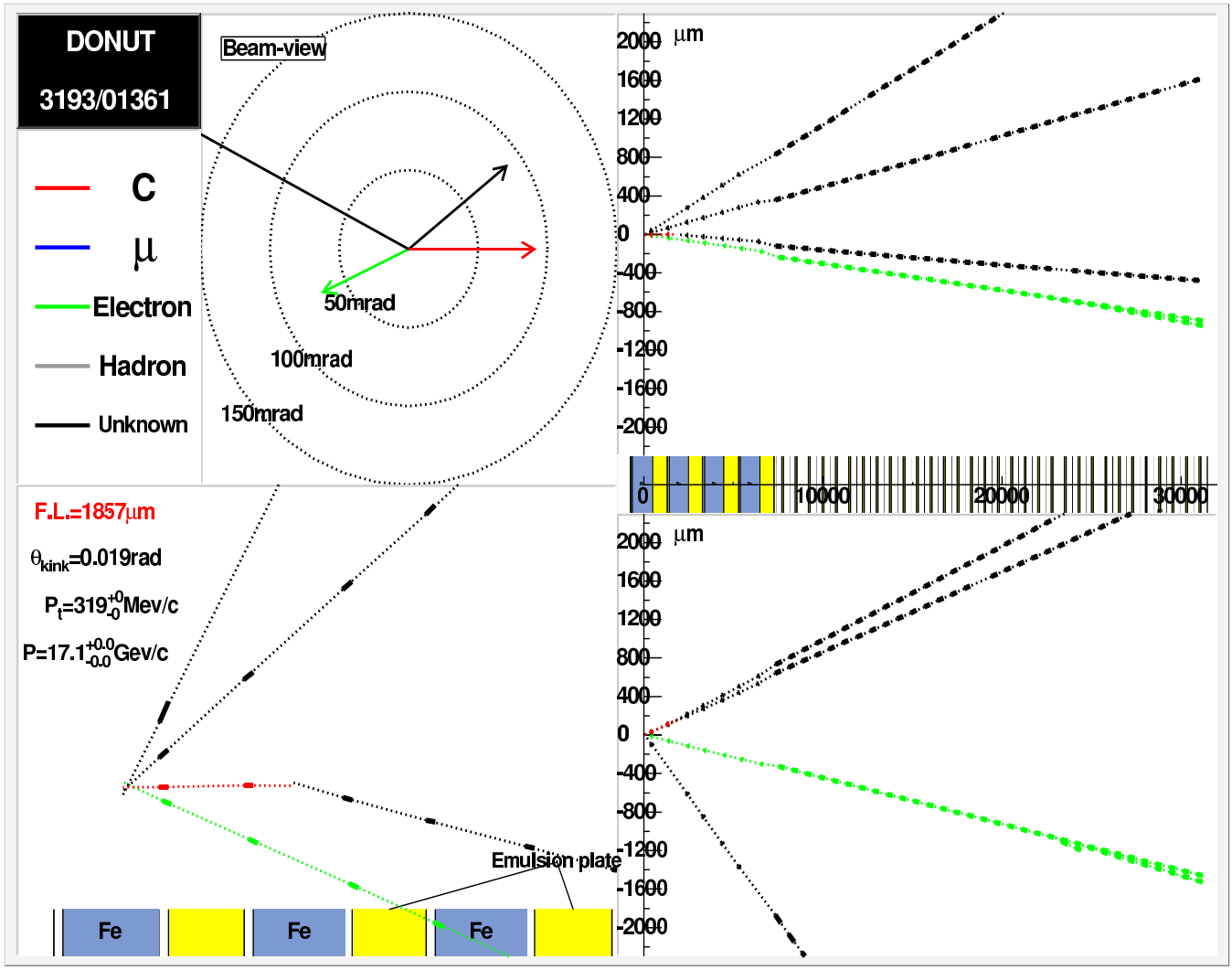
This event has a single prong kink and identified electron.

3065_03238				
θ (rad)	$\Delta\phi$	L (cm)	θ_k	P (GeV)
0.250	0.71	0.210	0.229	1.2

3065_03238			
Type	PP (no lep)	PP (lep)	PDF
Tau	0.0163	0.0000	0.32
Charm	0.0031	0.0104	2.02
Int.	0.0013	0.0028	0.45

3065_03238		
Type	P (no lep)	P (lep)
Tau	0.43	0.00
Charm	0.52	0.94
Int.	0.05	0.06

Event 3193_01361



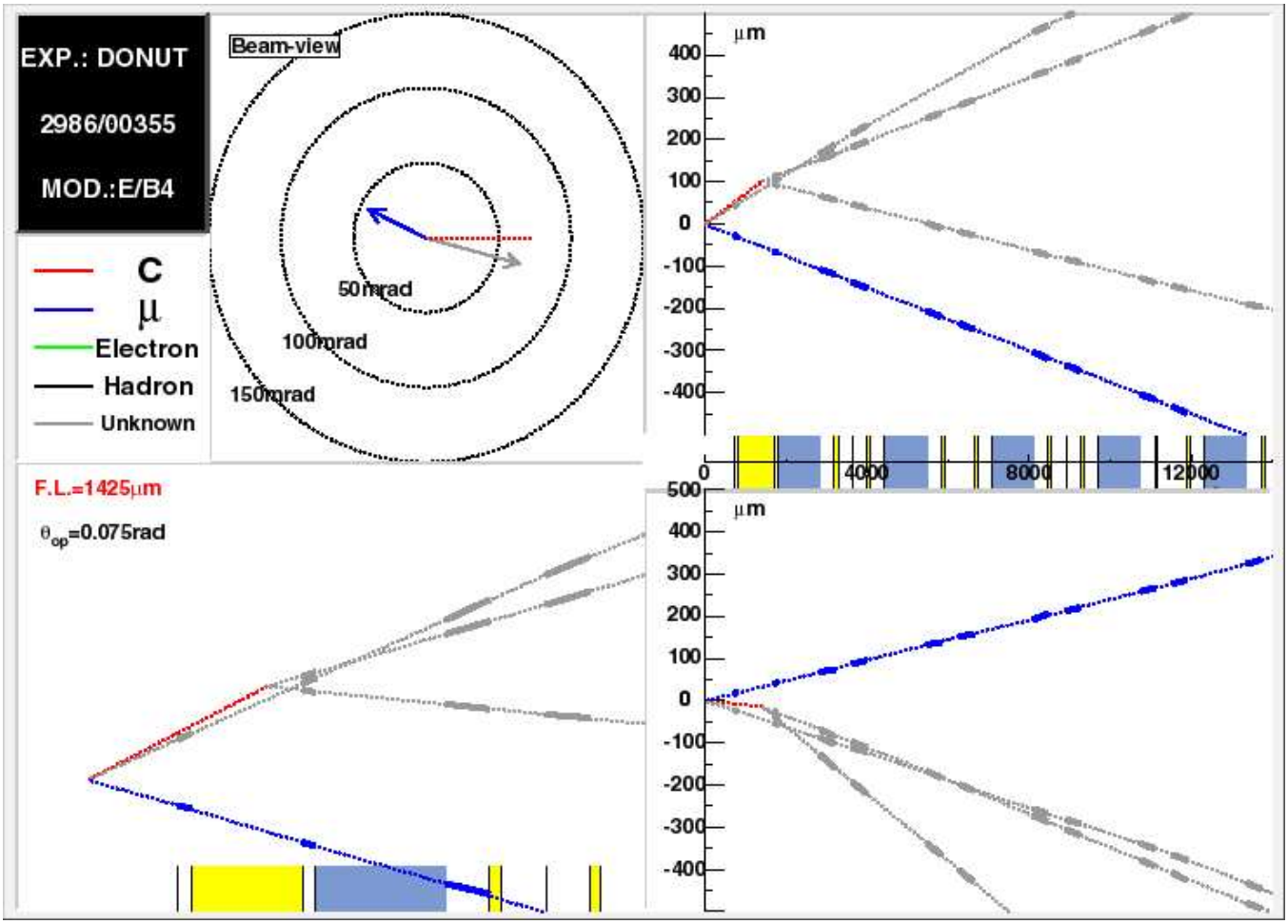
This event has a single prong kink and identified electron.

3193_01361				
θ (rad)	$\Delta\phi$	L (cm)	θ_k	P (GeV)
0.088	0.463	0.186	0.019	17.1

3193_01361			
Type	PP (no lep)	PP (lep)	PDF
Tau	0.0163	0.0000	4.30
Charm	0.0031	0.0104	6.46
Int.	0.0013	0.0028	0.30

3193_01361		
Type	P (no lep)	P (lep)
Tau	0.77	0.00
Charm	0.22	0.98
Int.	0.01	0.02

Event 2986_00355



This event has a neutral vee and a long decay which is not shown in this picture. There is an identified muon in this event. I do not use any information about the Vee in this analysis.

2986_00355				
θ (rad)	$\Delta\phi$	L (cm)	θ_k	P (GeV)
0.065	3.07	0.652	0.008	1.3

2986_00355			
Type	PP (no lepton)	PP (lepton)	PDF
Tau	0.0163	0.0000	97.7
Charm	0.0031	0.0104	425.8
Int.	0.0013	0.0028	0.11

2986_00355		
Type	P (no lep)	P (lep)
Tau	0.55	0.000
Charm	0.45	0.999
Int.	0.00	0.001

Prior Probabilities for Tridents

With no Identified leptons

- Tau

  $PP_\tau =< N_\tau > BR(\tau \rightarrow$ trident)

- Charm

  $PP_{charm} = \sum_i < N_{charm_i} > BR(charm_i \rightarrow$ trident) $P_{\text{lost lepton}}$

- Interaction

  $PP_{int} = \sum_i L_i P(\text{trident}) P_{\text{lost lepton}}$

With Identified Lepton from Primary Vertex

- Tau

  $PP_\tau = 0.00$

- Charm

  $PP_{charm} = \sum_i < N_{charm_i} > BR(charm_i \rightarrow$ trident)

- Interaction

  $PP_{int} = \sum_i L_i P$(trident)

With Identified Lepton from both Primary and Secondary Vertices

- Tau

  $PP_\tau = 0.00$

- Charm

  $PP_{charm} = \sum_i < N_{charm_i} > BR(charm_i \rightarrow \mu$ -trident)

  Two possibilities:

  - Charm decays to $\mu + 2$ charged particles (the branching ratios I used to calculate $P(\mu$ -trid) are listed on page 15).

Type	$< N >$	$BR(\mu$ -trid)	PP
D	4.67	0.0334	0.160
D_s	1.75	0.02	0.035
Λ_c	1.95	0.00	0.00

- Charm decays to 3 charged particles, where one is a π and one π decays to a μ before μ-ID (the BRs I used are listed on page 16)

  $PP = \Sigma < N > BR(\pi \text{ -trid}) N_\pi P(\pi \rightarrow \mu\nu_{mu})$

Type	$< N >$	$BR * N_\pi$	$P(\pi \rightarrow \mu\nu_{mu})$	PP
D	4.67	0.927	0.0195	0.0844
D_s	1.75	0.230	0.0195	0.0078
Λ_c	1.95	0.355	0.0195	0.0135
Total				0.1058

This decay must happen before the muon ID which is about 11 m from target. So the probability of having a μ from the secondary vertex is related to the probability that the pion will decay before the muon ID .

$P(\mu$ from secondary) α $1 - e^{\frac{-t}{\tau}}$, where

τ = 2.6x10^{-8} and $t = \frac{L}{\gamma} = \frac{L}{\frac{E}{m}}$ and the momentum of the $\pi = 10GeV \simeq E$, so $t = 0.51ns$, and $1 - e^{-t/\tau} = 0.0195$

Charm trident decays with μ + 2 charged particle:

Parent	Decay Mode	BR
$D^{\pm}$	$K^{-}\pi^{+}\mu^{-}\nu_{\mu}$	0.032
$D^{\pm}$	$\rho^{0}\mu^{+}\nu_{\mu}$	0.0027
$D^{\pm}$	Total	0.0347
D_s	$\phi l^{+}\nu_{l}$	0.02
D_s	Total	0.02

Charm trident decays with π + 2 charged particles:

Parent	Decay Mode	BR	N_π	BR*N_π
D^+	$K^-\pi^+e^+\nu_e$	0.041	1	0.041
D^+	$K^-\pi^+\pi^+$	0.091	2	0.182
D^+	$K^-\pi^+\pi^+\pi^0$	0.064	2	0.128
D^+	$\bar{K}^0\pi^+\pi^+\pi^-$	0.07	3	0.21
D^+	$K^+K^-\bar{K}^0\pi^+$	0.00054	1	0.00054
D^+	$\bar{K}^0\rho^0\pi^+$	0.042	2	0.084
D^+	$\bar{K}^0\pi^+\pi^+\pi^-\pi^0$	0.054	3	0.162
D^+	$\bar{K}^*\pi^+\pi^+\pi^-$	0.0082	3	0.0246
D^+	$\pi^+\pi^+\pi^-$	0.0031	3	0.0093
D^+	$\pi^+\pi^+\pi^-\pi^0$	0.00069	3	0.00207
D^+	$\rho^0\pi^+$	0.001	1	0.001
D^+	$K^+K^-\pi^+$	0.0088	1	0.0088
D^+	$K^+K^-\pi^+\pi^0$	0.026	1	0.026
D^+	$K^+\bar{K}^0\pi^+\pi^-$	0.004	2	0.008
D^+	$K^0K^-\pi^+\pi^+$	0.0054	2	0.0108
D^+	$\phi\pi^+$	0.0061	1	0.0061
D^+	$\phi\pi^+\pi^0$	0.023	1	0.023
D^+	Total			0.9272

Parent	Decay Mode	BR	N_π	BRN_π
D_s^+	$K^+K^-\pi^+$	0.044	1	0.044
D_s^+	$K^+\bar{K}^0\pi^+\pi^-$	0.025	2	0.05
D_s^+	$K^0K^-\pi^+\pi^+$	0.043	2	0.086
D_s^+	$\pi^+\pi^+\pi^-$	0.01	3	0.03
D_s^+	$K^+\pi^+\pi^-$	0.01	2	0.02
D_s^+	Total			0.230

Parent	Decay Mode	BR	N_π	BRN_π
Λ_c	$pK^-\pi^+$	0.005	1	0.005
Λ_c	$p\bar{K}^0\pi^+\pi^-$	0.026	2	0.052
Λ_c	$pK^-\pi^+\pi^0$	0.034	1	0.034
Λ_c	$pK^-\pi^+\pi^0\pi^0$	0.008	1	0.008
Λ_c	$p\pi^+\pi^-$	0.0035	2	0.007
Λ_c	$\Lambda\pi^+\pi^+\pi^-$	0.033	3	0.099
Λ_c	$\Sigma^+\pi^+\pi^-$	0.036	2	0.072
Λ_c	$\Sigma^-\pi^+\pi^+$	0.019	2	0.038
Λ_c	$\Sigma^0\pi^+\pi^+\pi^-$	0.011	3	0.033
Λ_c	$\Xi^-K^+\pi^+$	0.0049	1	0.0049
Λ_c	$\Sigma^+K^+\pi^-$	0.0017	1	0.0017
Λ_c	Total			0.3546

- Interaction

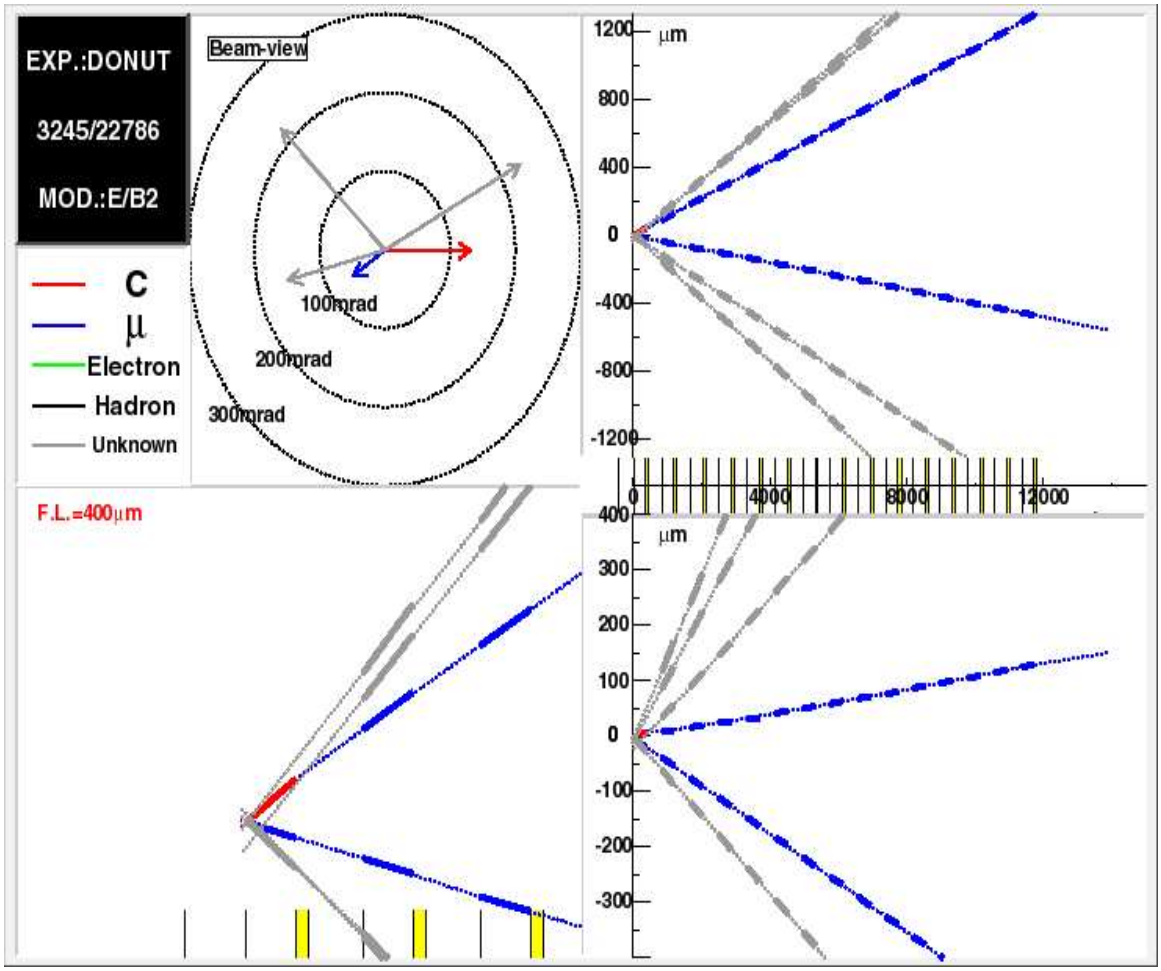
  $PP_{int} = \sum_i L_i P(\text{interaction}) P(\pi \text{ -trident}) P(\pi \rightarrow \mu\nu_\mu)$,

  where L_i is the length of material i traversed, P(interaction) is the probability that a hadron interacts in material i and produces 3 charged particles, $P(\pi$ -trident) is the probability that one of the charged particles is a π, and $P(\pi \rightarrow \mu\nu_\mu)$ is the probability that the π will decay to a μ before the μ-ID.

  I used the MC to calculate $P(\pi$ -trident), which is 99%.

Material	L	P(int)	$P(\pi \rightarrow \mu\nu_\mu)$	PP
Iron	3700	0.00216	0.0195	0.156
Emulsion	1900	$< 10^{-5}$	0.0195	0.00
Acrylic	2900	$< 10^{-5}$	0.0195	0.00
Total				0.156

Event 3245_22786



This event is a trident, but one of the daughters has and angle of > 400 mr, so it is not shown here. There is an identified μ from both vertices. Both vertices occur in emulsion.

3245_22786			
θ (rad)	$\Delta\phi$ (rad)	L (cm)	Σ IP
0.141	0.157	0.040	0.0128

Prior Probabilities			
Type	PP (no lep)	PP (lep)	PP (2 lep)
Tau	0.0059	0.0000	0.000
Charm	0.0019	0.0063	0.300
Int.	0.0055	0.0180	0.156

Three Parameter Analysis				
Type	PDF	P (no lep)	P (lep)	P (2 lep)
Tau	0.0008	0.00	0.00	0.00
Charm	0.0510	0.09	0.09	0.33
Int.	0.1980	0.91	0.91	0.67

Four Parameter Analysis				
Type	PDF	P (no lep)	P (lep)	P (2 lep)
Tau	32.20	0.11	0.00	0.00
Charm	221.6	0.24	0.27	0.67
Int.	210.3	0.65	0.73	0.33

The secondary interaction occurs in emulsion. This information will decrease the prior probability of interaction by the ratio of the cross section in emulsion to the cross section in iron. In my analysis, I found that this ratio is $< 10^{-5}$. With this information the relative probabilities become:

Type	PDF	PP	P
Tau	32.2	0.00	0.00
Charm	221.6	0.0805	1.00
Interaction	210.3	$< 10^{-5}$	0.00

Event 3073_22977

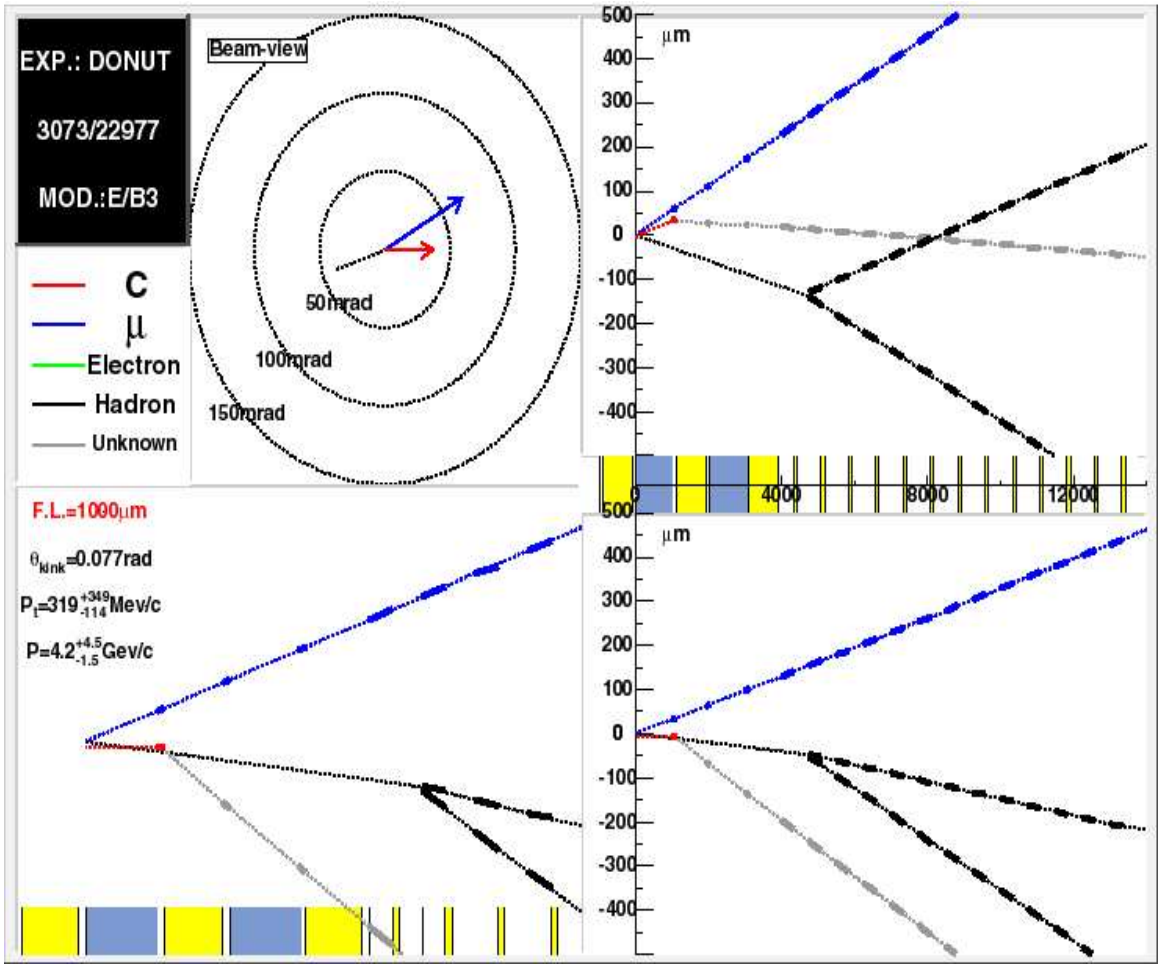
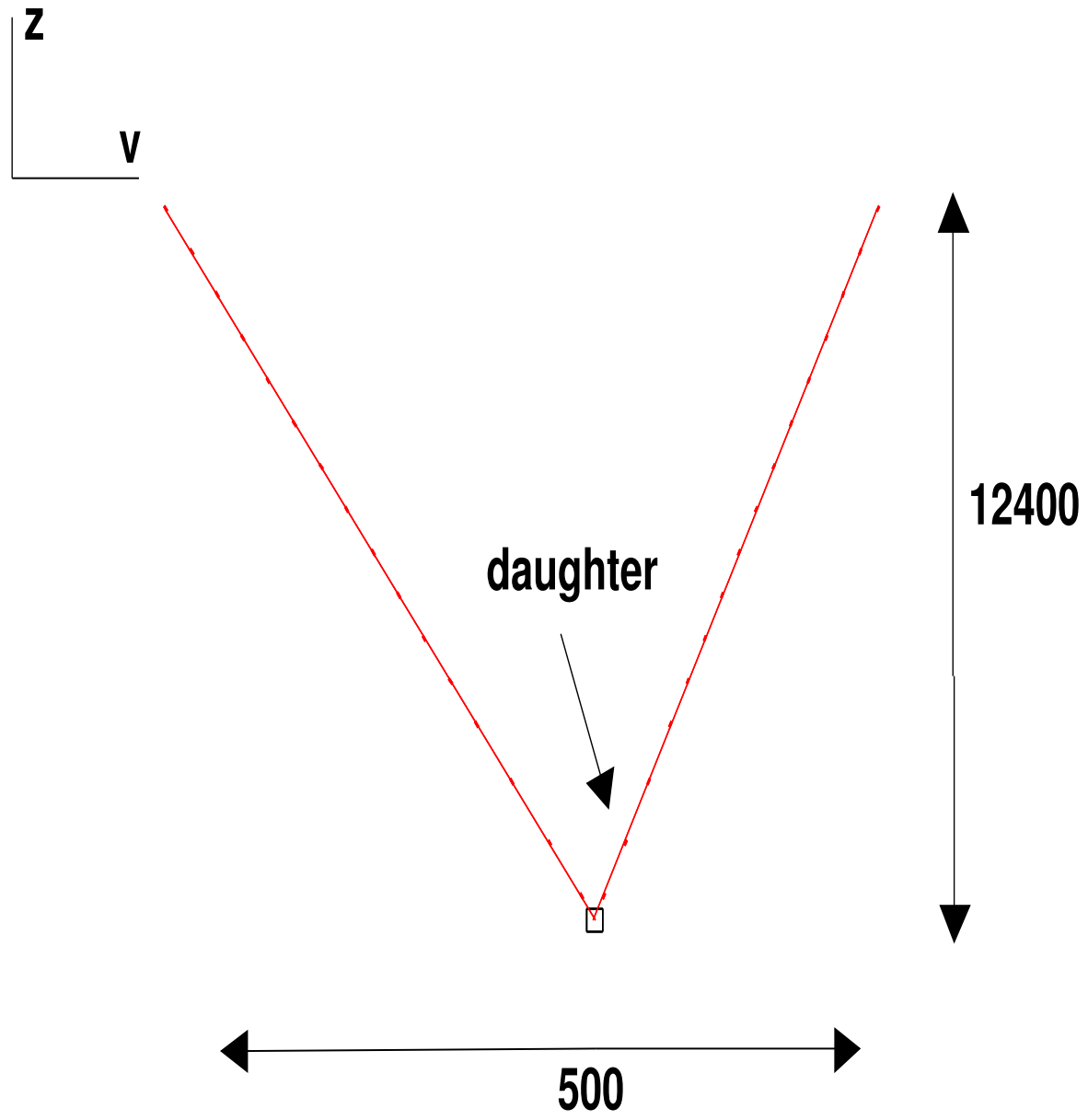
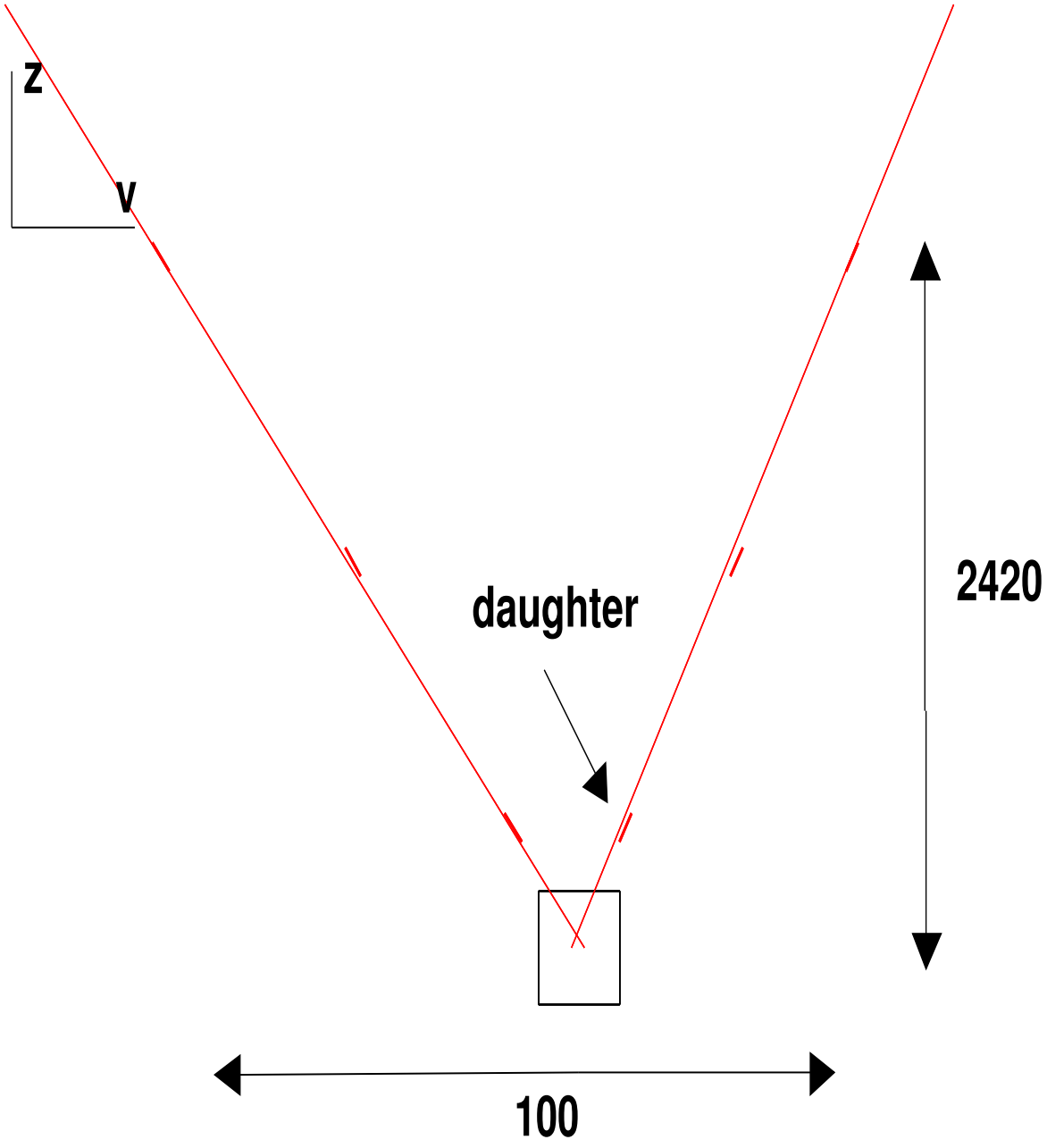


plate	trkid	comment
351	1003486	muon
351	1003490	charged daughter
351	1	neutral parent
321	1006457	neutral daughter
321	1006474	neutral daughter

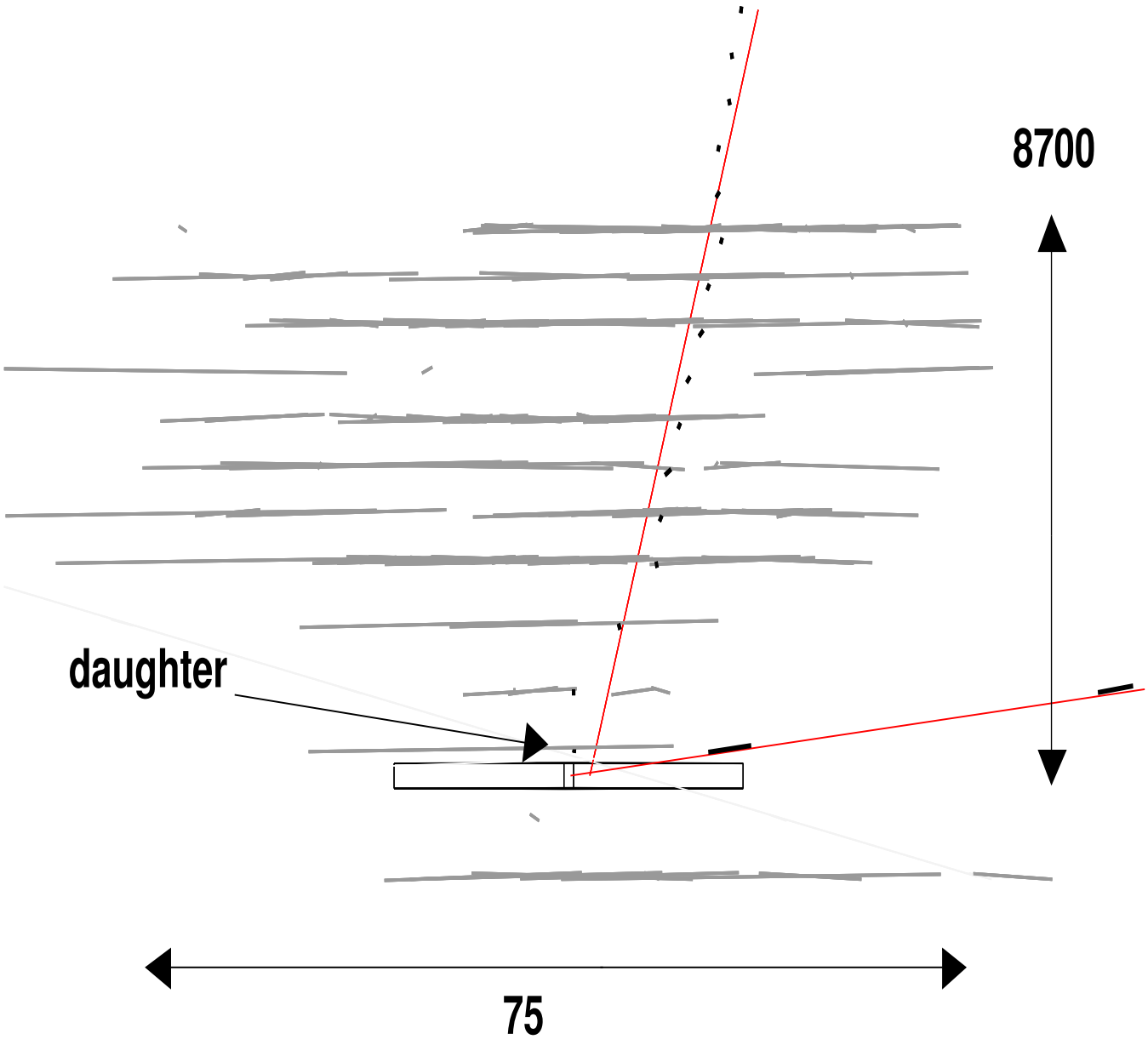
Vertex:



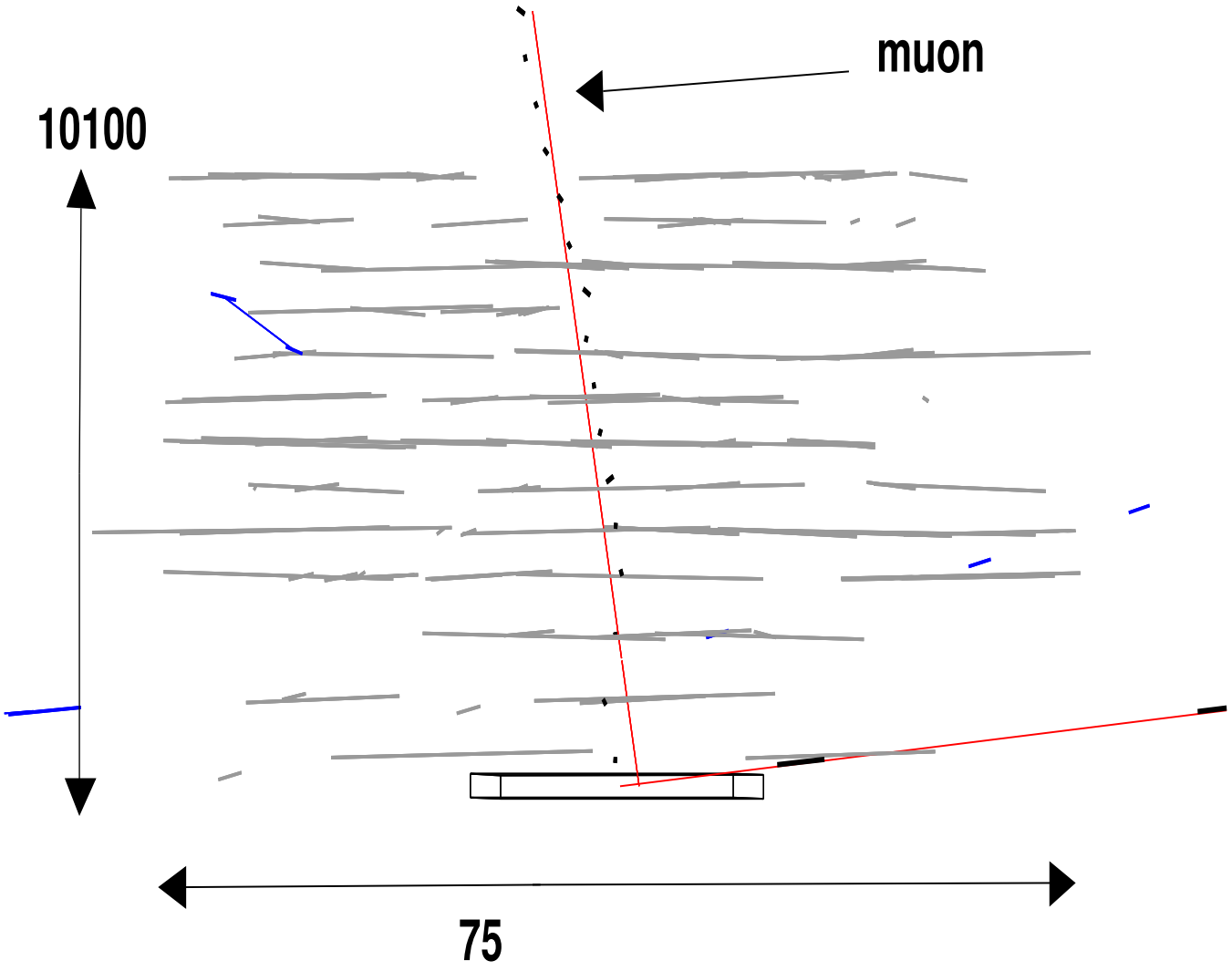
Close up of vertex:



Daughter through 10 emulsion plates (slipping?):



Muon through 10 emulsion plates (slipping?):



Conclusions on 3073_22977:

I cannot find any evidence that this is a kink.

I cannot construct a unique track in order to do my paramerter analysis.

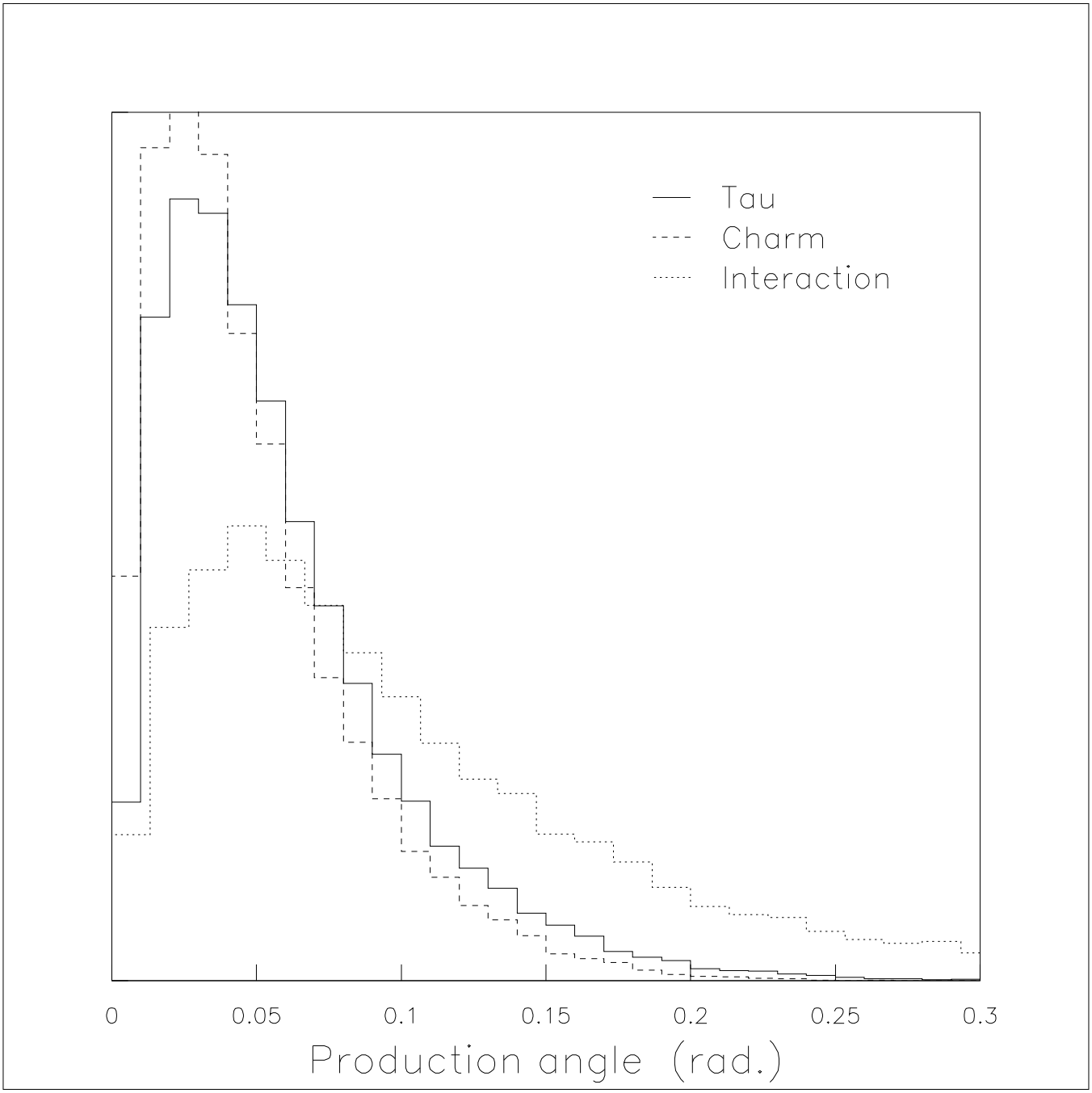
Overall Conclusions:

- According to my parameter analysis 3065_03238, 3193_01361, and 2986_00355 are all most likely to be charm.

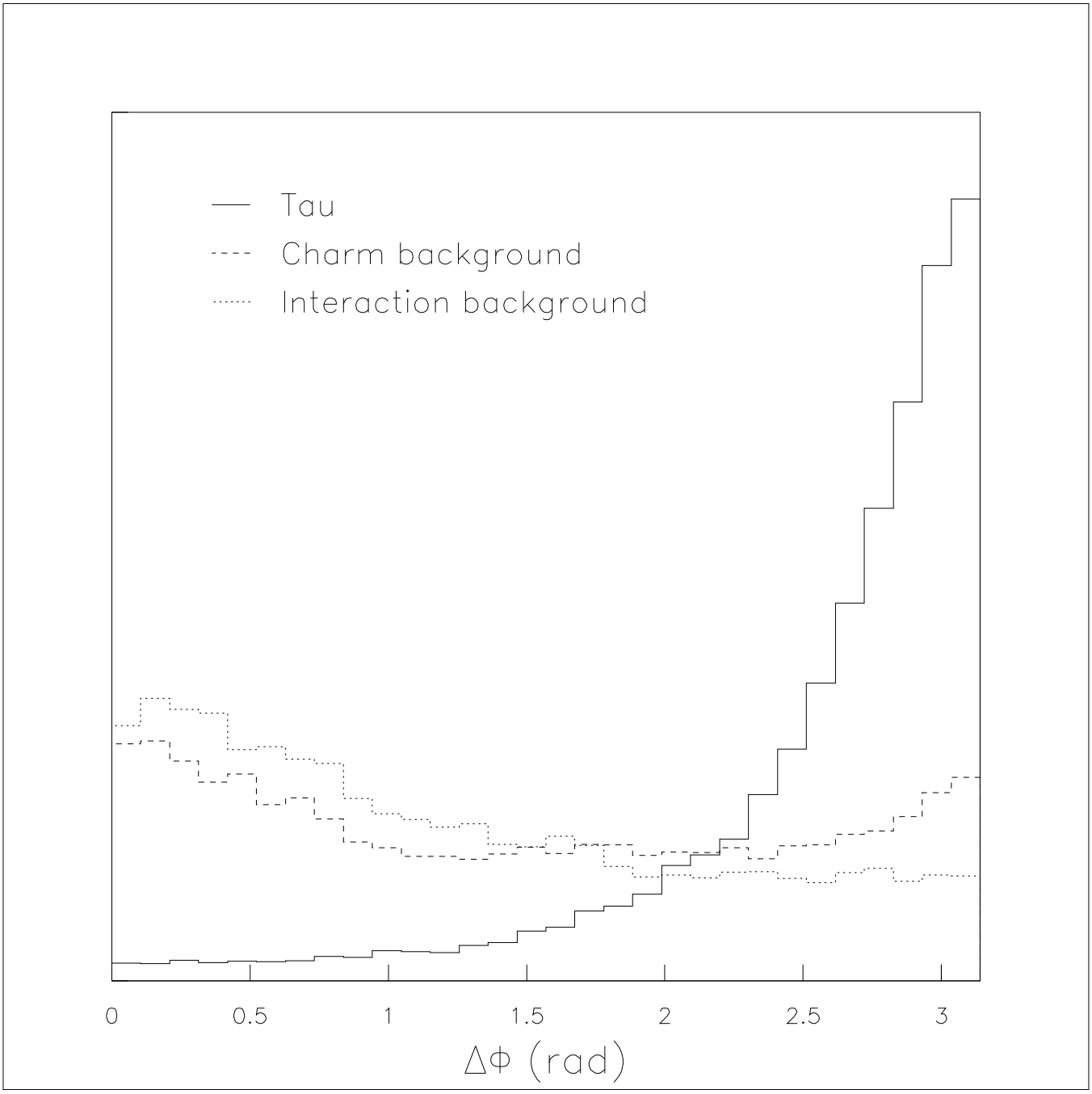
- The event topology of 3245_22786 looks more charm-like than interaction-like according to the four parameter analysis. The fact that the secondary vertex is in emulsion and there is a muon coming from the vertex make the event look charm-like.

- I see no evidence of 3073_22977 having a kink, so I cannot perform the parameter analysis on this event.

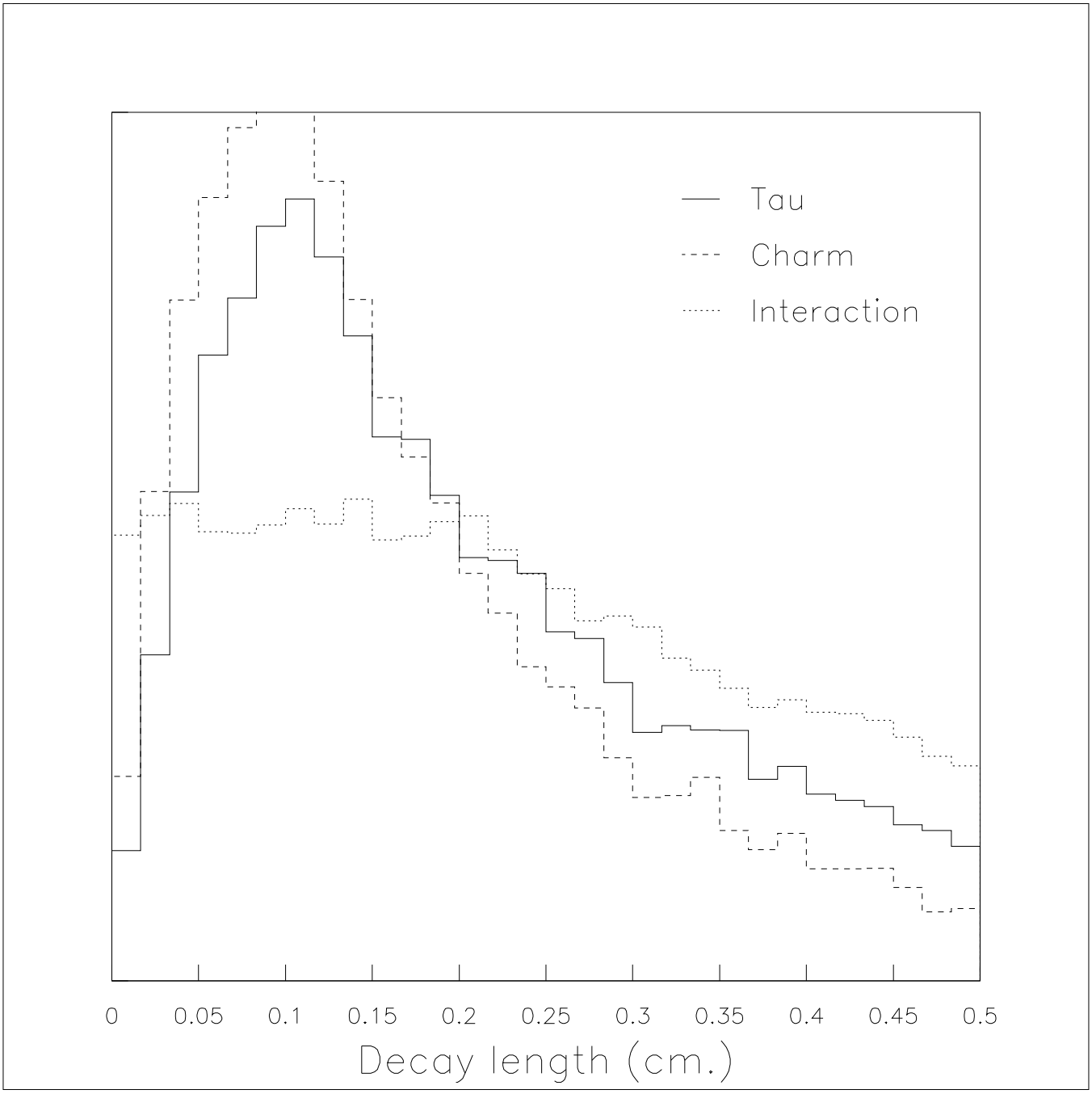
Theta Distributions



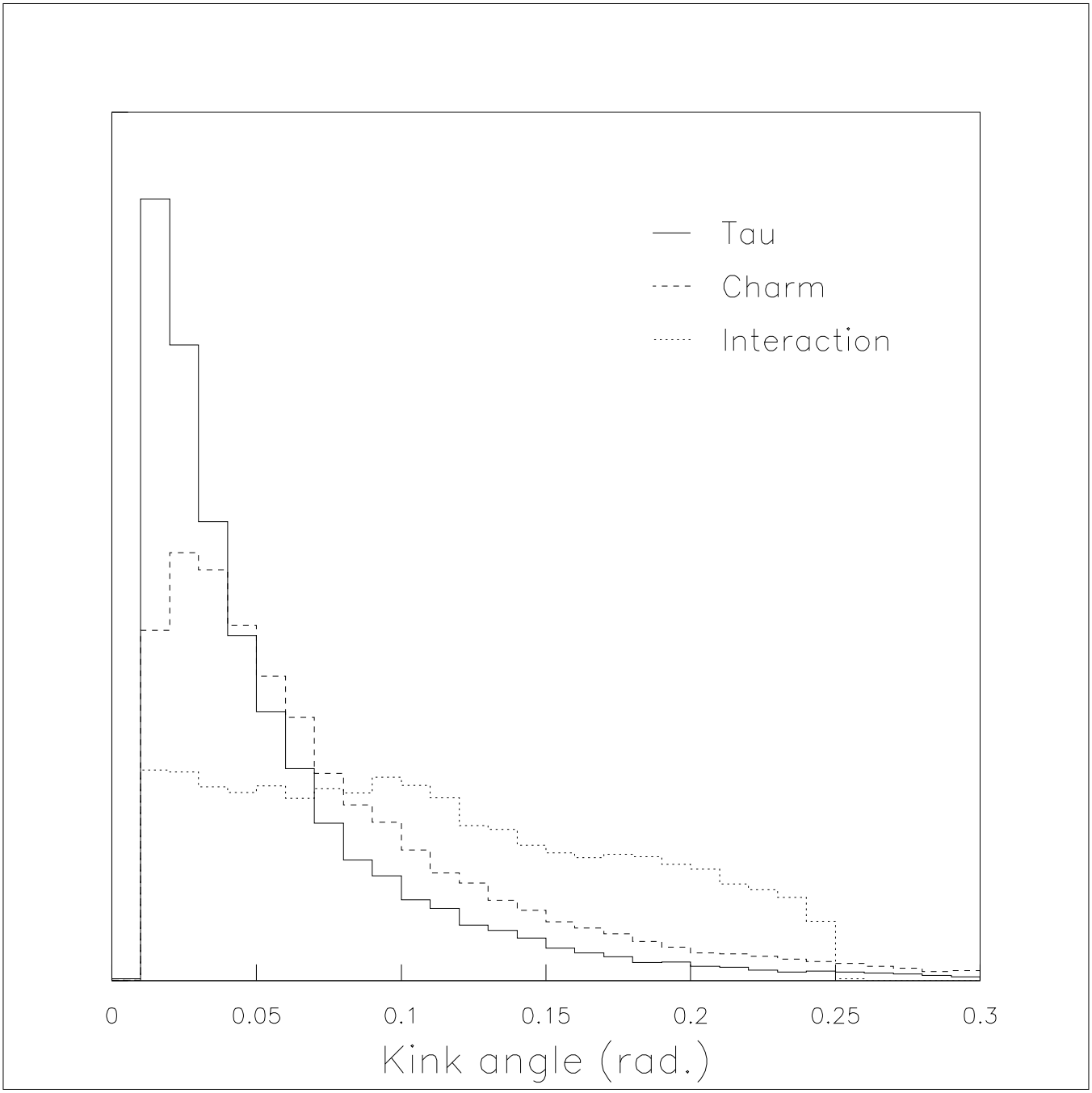
Delta Phi Distributions



Length Distributions



Kink Angle Distributions



Momentum Distributions