Branching Fraction of Ke3ee

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Home work given in last KTeV meeting (9/10)

- Effect of cross track event in X-view in TRD
- Radiative correction vs. Next leading order of ChPT
- BG from Cascade, 1.7 events/19466signal
- BG from Double Ke3, 29.1events/19466signal

New Result of BR(Ke3ee)

Trigger 4, NZF002~038

Normalization mode = $K_L \rightarrow \pi^+\pi^-\pi^0{}_D$ (pm0d)

For both Ke3ee (singal)
and pm0d (normalization)

- 3V_TIGHT * 2DC12_MED * ET_THR1 * !MU2 * PHVBAR1* 34HCY * HCC_GE2 *YTF_UDO * HC2XDUM
- '97 winter (NZF002~NZF038)

Event Selection

Pick up $\pi^{\pm}e^{\mp}e^{+}e^{-}$...ke3ee
$\pi^{+}\pi^{-}e^{+}e^{-}$..pm0d

EKaon < 200 GeV (Both soln.)	
95 < Z vertex < 150 m	
Vertex χ^2 < 125	
0.93 < E/p < 1.15 for electron tracks	
E/p < 0.9 for pion tracks	
TRD probability < 0.06 for electron tracks	
$Ee^{\pm}$(pair) > 3 GeV	
Me+e- > 0.005 GeV/c^2	
for Ke3ee	for pm0d
$M\pi^{\pm}e^{+}e^{+}e^{-}$ < 0.5 GeV/c^2	0.492 < Mpm0 < 0.504 GeV/c^2
-	0.127 >$Me^{+}e^{-}g$> 0.143 GeV/c^2
pp0kine < - 0.002 (GeV/c)^2	pp0kine > - 0.002 (GeV/c)^2
$Ee^{\pm}$(Ke3) > 10 GeV	-
$E\pi^{\pm}$ > 10 GeV	$E\pi^{\pm}$ > 8 GeV (for one $\pi^{\pm}$)

Background

- $K_L \rightarrow \pi^+\pi^- \pi^0_D$ $(\pi^0 \rightarrow e^+e^-\gamma)$

  ↘ One $\pi^\pm$ fakes $e^\pm$

- $K_L \rightarrow \pi^\pm e^+\nu\ \pi^0_D$ $(\pi^0 \rightarrow e^+e^-\gamma)$

- $K_L \rightarrow \pi^\pm e^+\nu\ \gamma$

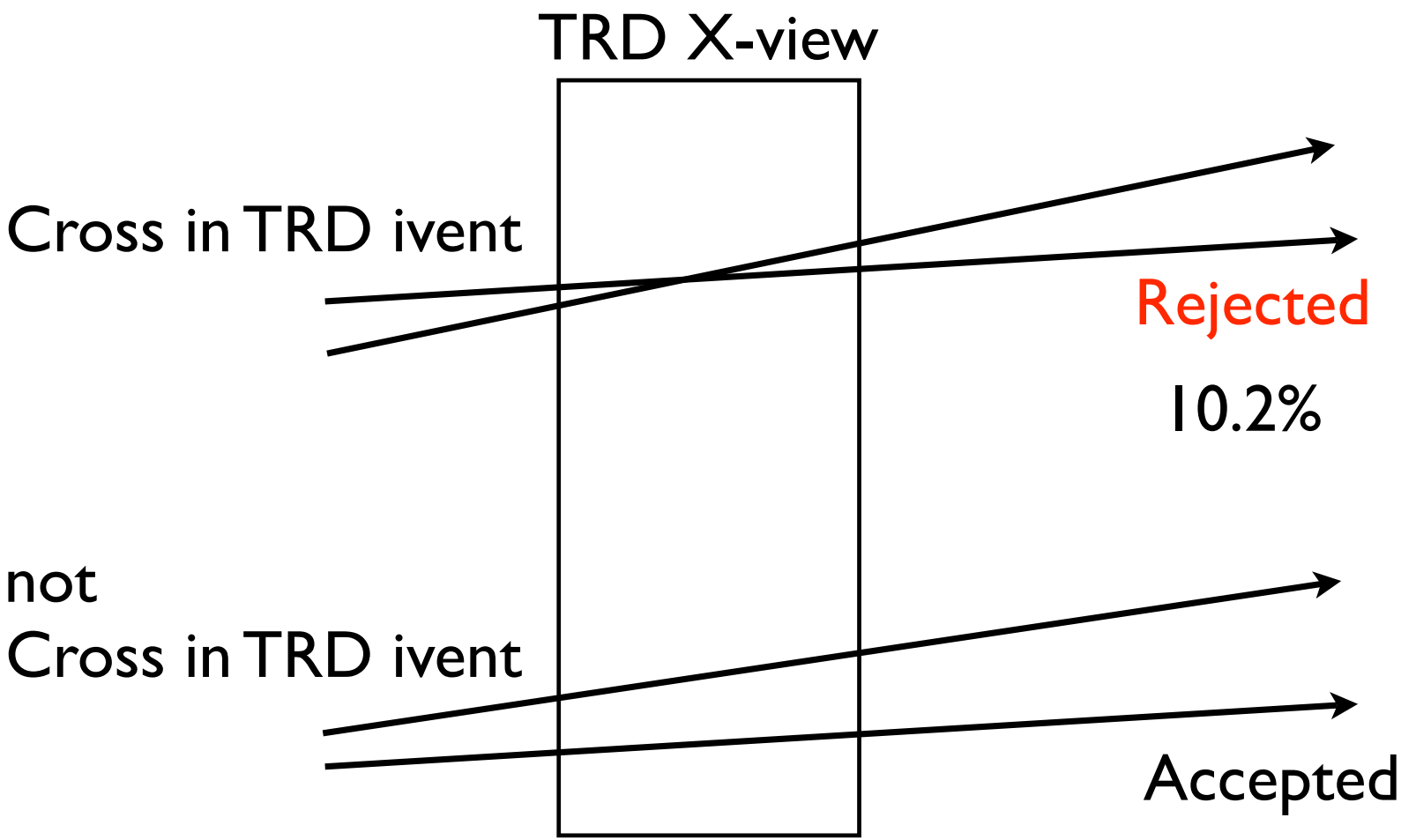
  ($\gamma \rightarrow e^+e^-$: external conversion)

- $K_L \rightarrow \pi^+\pi^- \pi^0_{4e}$ $(\pi^0 \rightarrow e^+e^-e^+e^-)$

- $\Xi \rightarrow \Lambda\, \pi^0_D$ $(\Lambda \rightarrow P\ e^+)$ $(\pi^0 \rightarrow e^+e^-e^+e^-)$

- Double Ke3 $K_L \rightarrow \pi^\pm e^+\nu + K_L \rightarrow \pi^\pm e^+\nu$

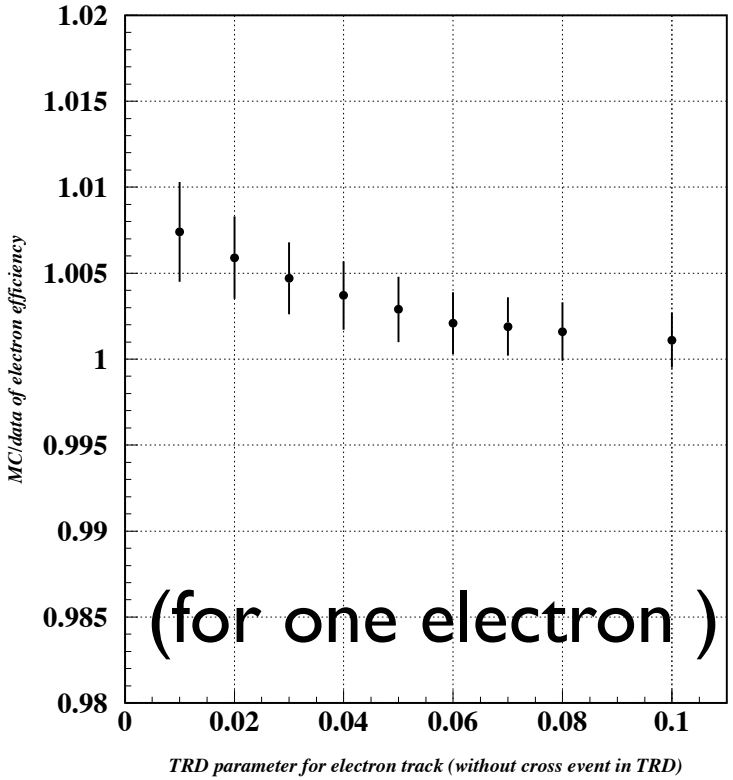
To select cross track event in X-view in TRD



- Effect of cross track event in X-view in TRD

Study using pm0d events collected by M_K

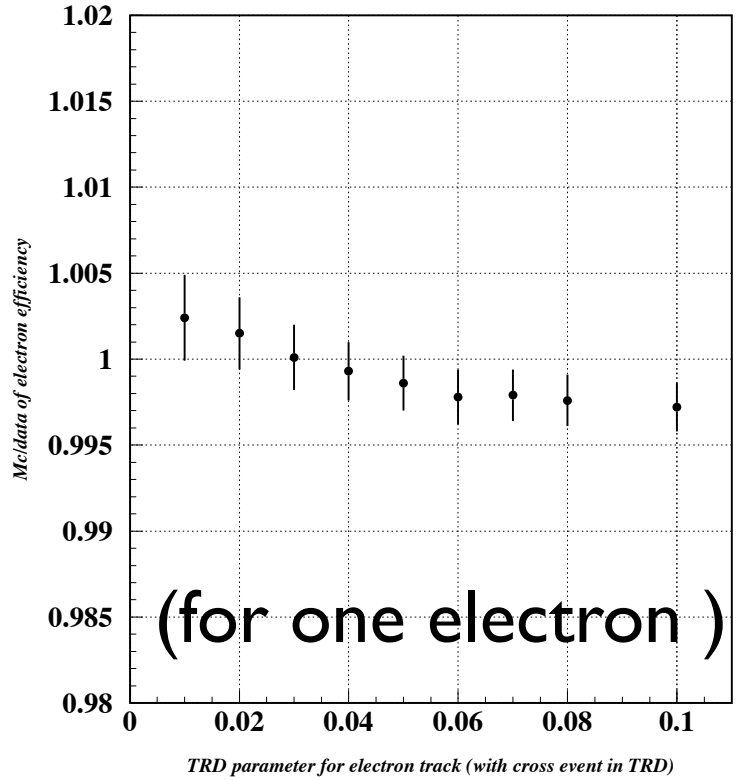
Removed cross event in TRD



$e^{\pm}$ like ⟷ $\pi^{\pm}$ like

TRD prob. <

with cross event in TRD



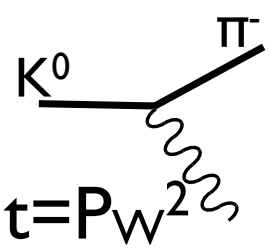
$e^{\pm}$ like ⟷ $\pi^{\pm}$ like

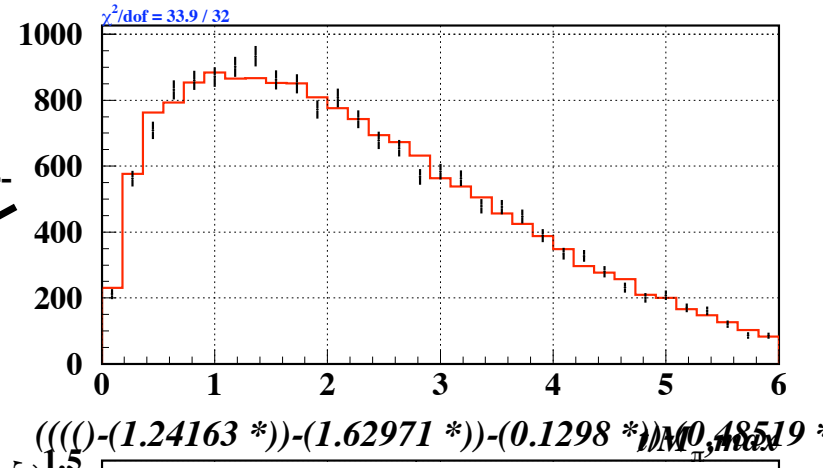
TRD prob. <

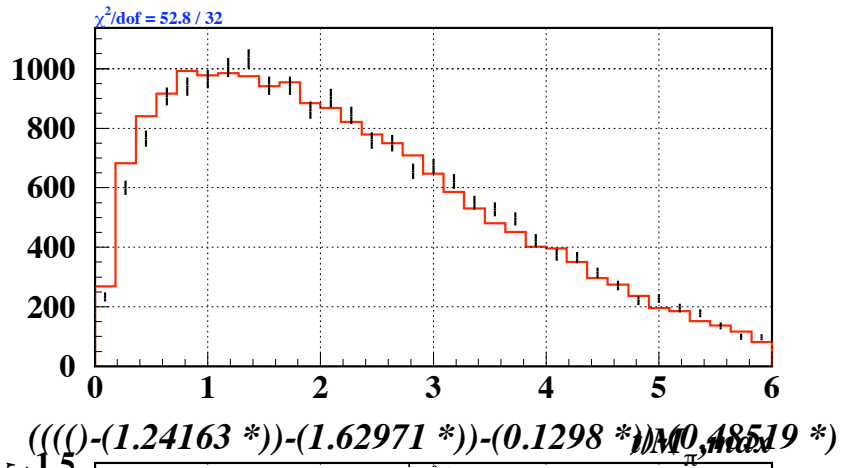
Cut variation due to this effect is same for both

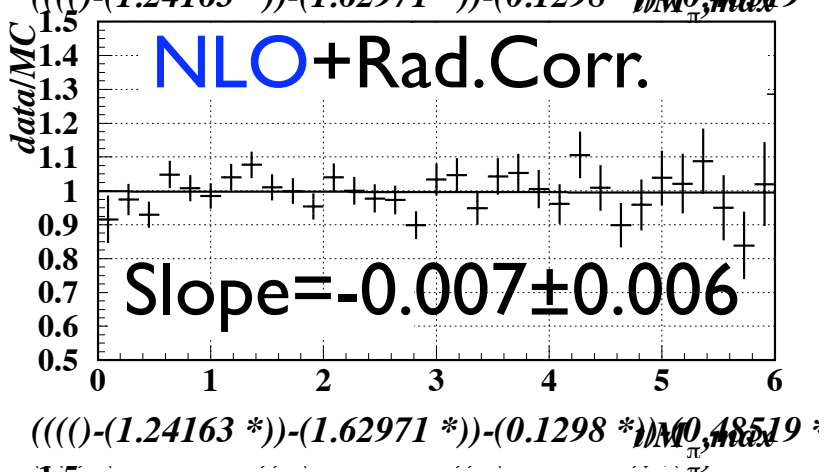
Data/MC improvement on "t/M_π^2"

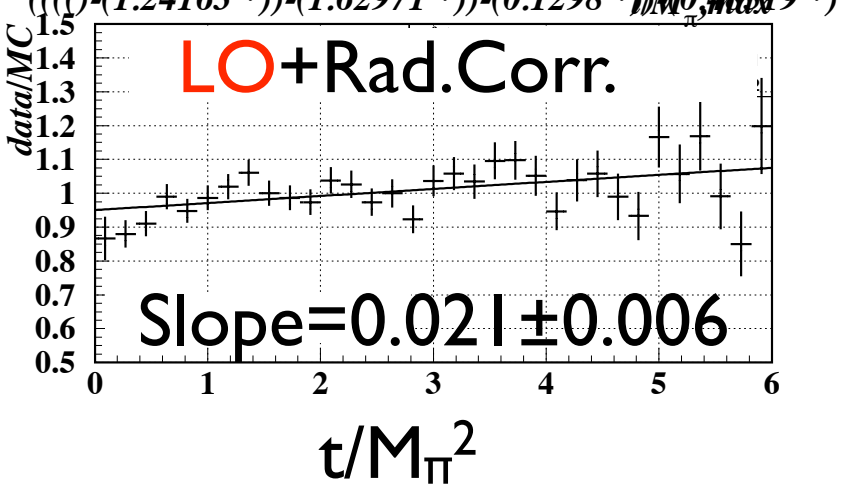
Radiative correction ?
or
ChPT Next LO ?

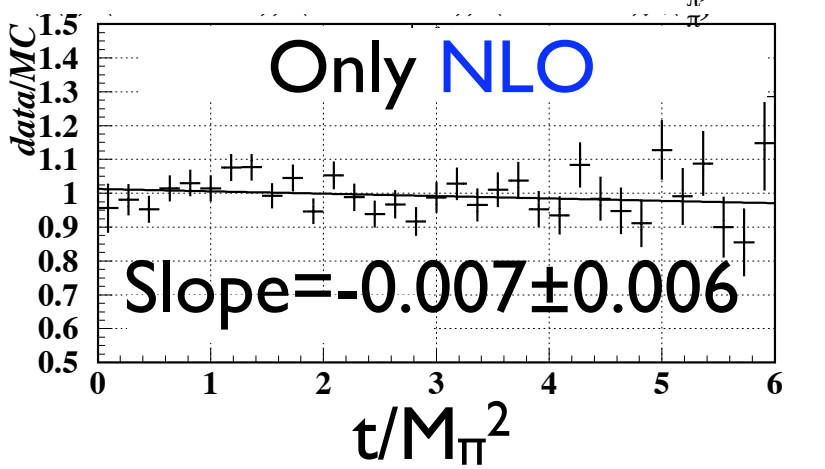












Modified points on the estimation of BR

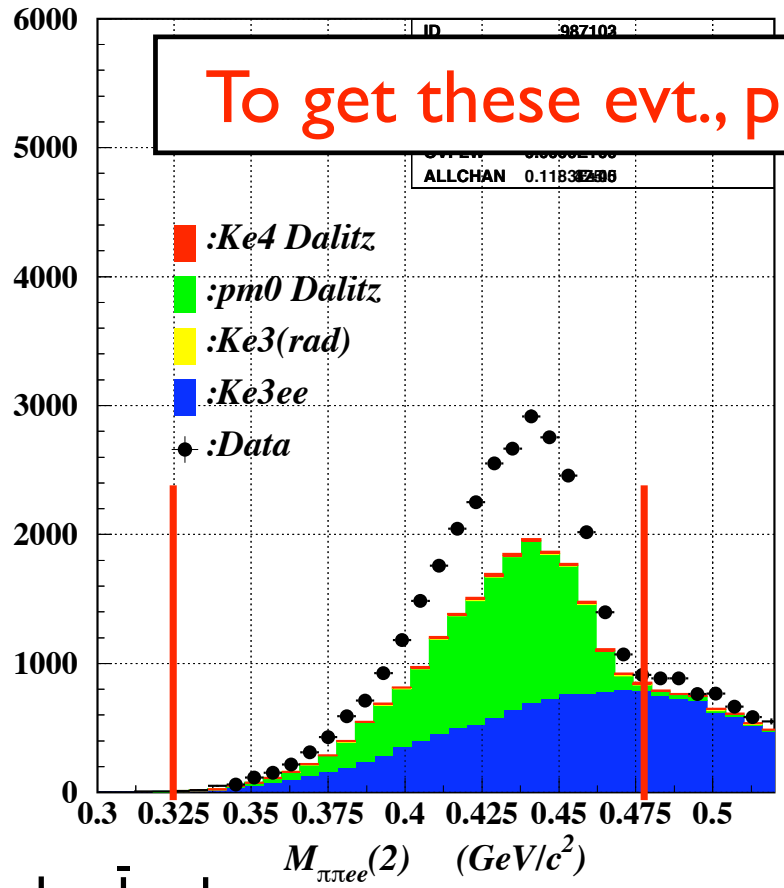
- Correction for π-e fake ratio is estimated for every change of cut values.
- Lost pion ratio in TRD is calculated for each pion in each event, then weighted.
- 'Rejection of excess track event in DC1 and DC2' (for $K_L \rightarrow \pi^+\pi^-\pi^0_{4e}$ Rejection) is removed.

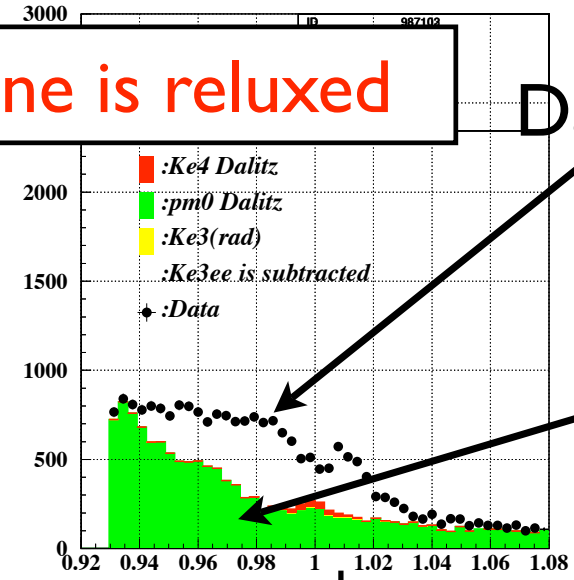
Other issues on BR estimation

- Vertex χ^2
- Systematic error and Statistic error sumary.

Measurement the discrepancy between Data-MC on $\pi^{\pm}$ fakes $e^{\pm}$

To get these evt., pp0kine is reluxed





Data-Signal

MC pm0d

E/p for $\pi^{\pm}$ fake $e^{\pm}$

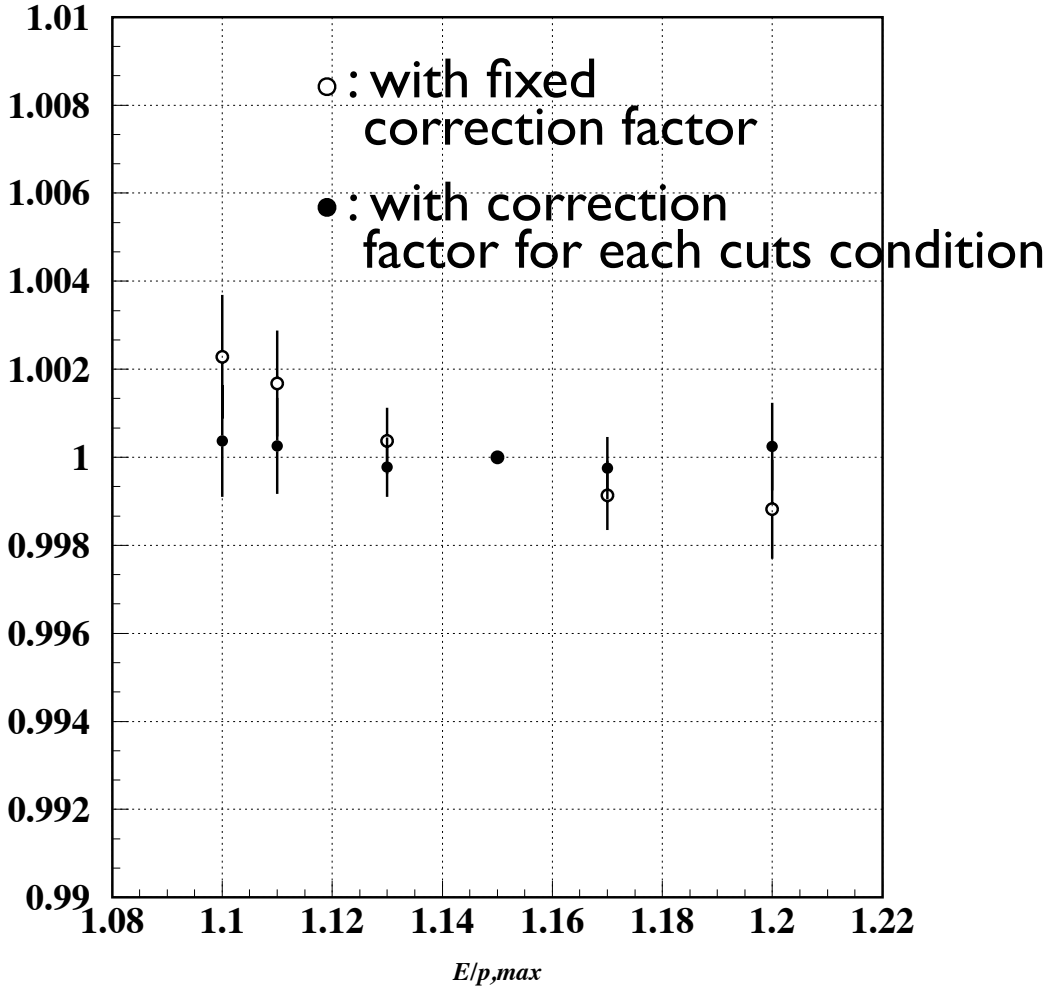
$\pi^{\pm}e^{\mp}e^{+}e^{-}$ event

$\Rightarrow \pi^{\pm}\pi^{\mp}e^{+}e^{-}$ Mass

MC is lacking πs which have E/p close to One

Correction factor on this defect is estimated for every cut set.

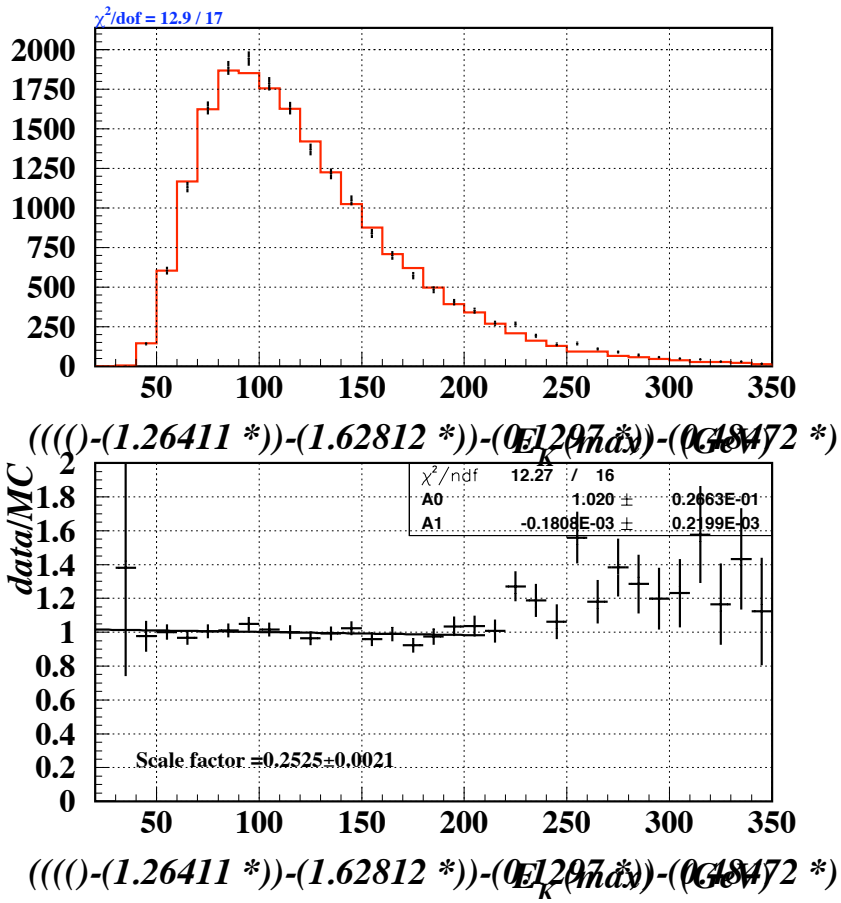
Correction factor for π faking electron should be estimated for every cuts condition.

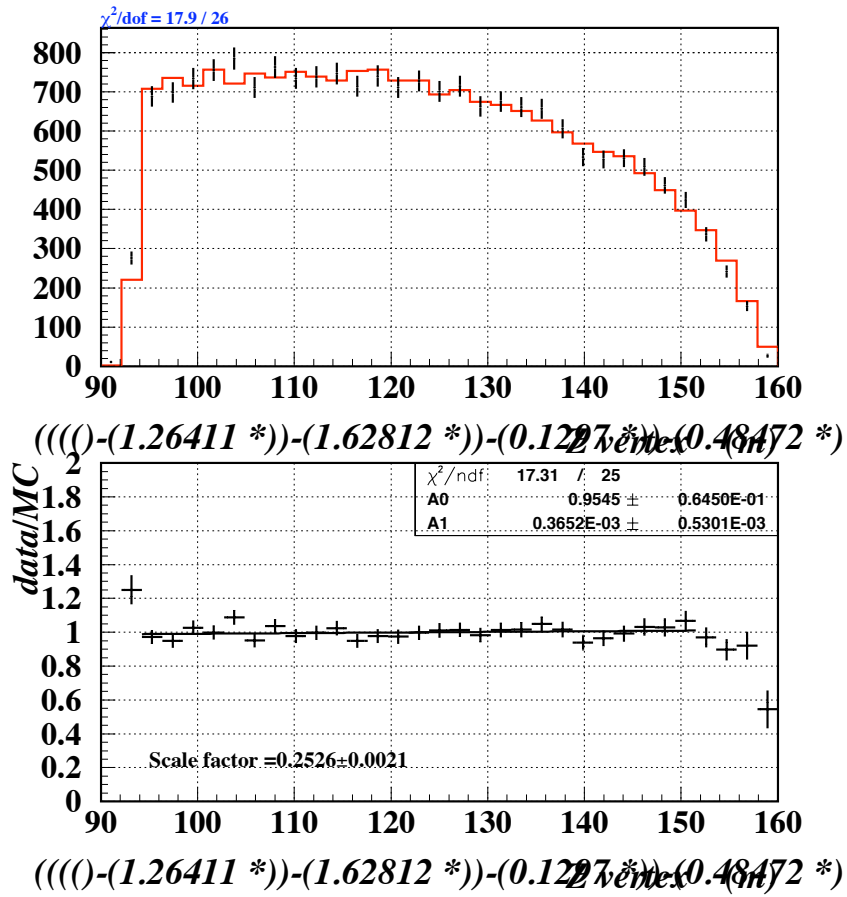


E/p max for electron track

Data (BG subtracted)/MC comparison

Energy of Kaon and Z-vetex

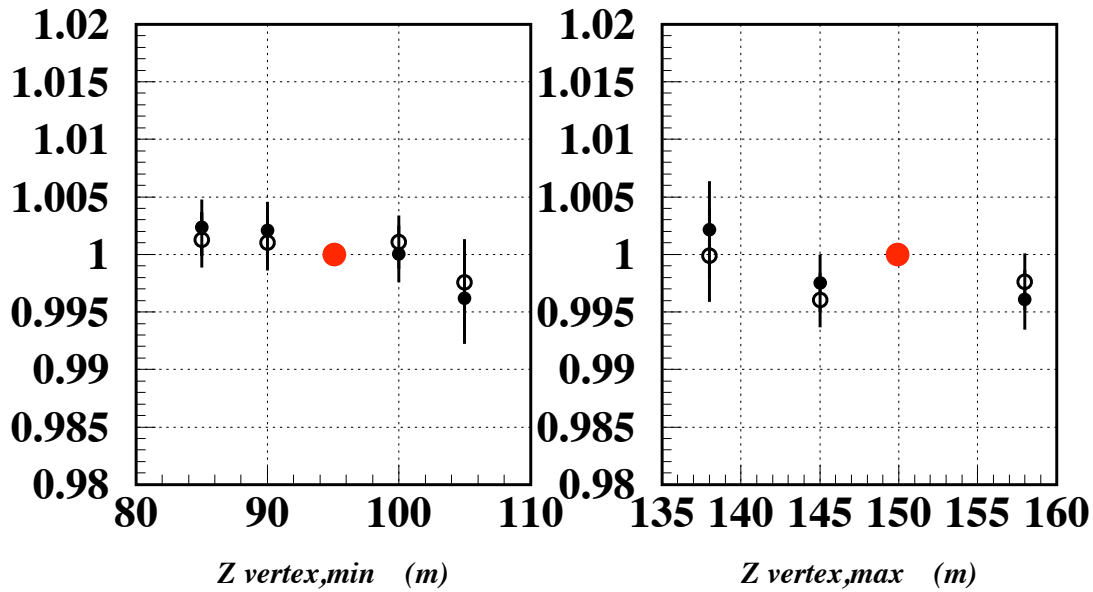


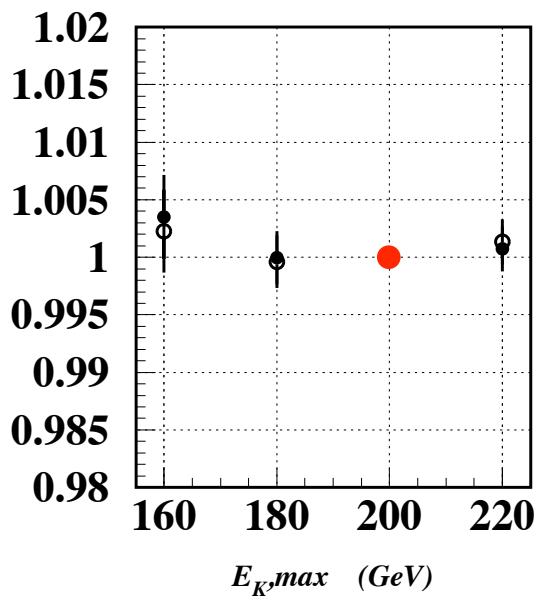


E_K,max soln. (GeV)

Z-vertex (m)

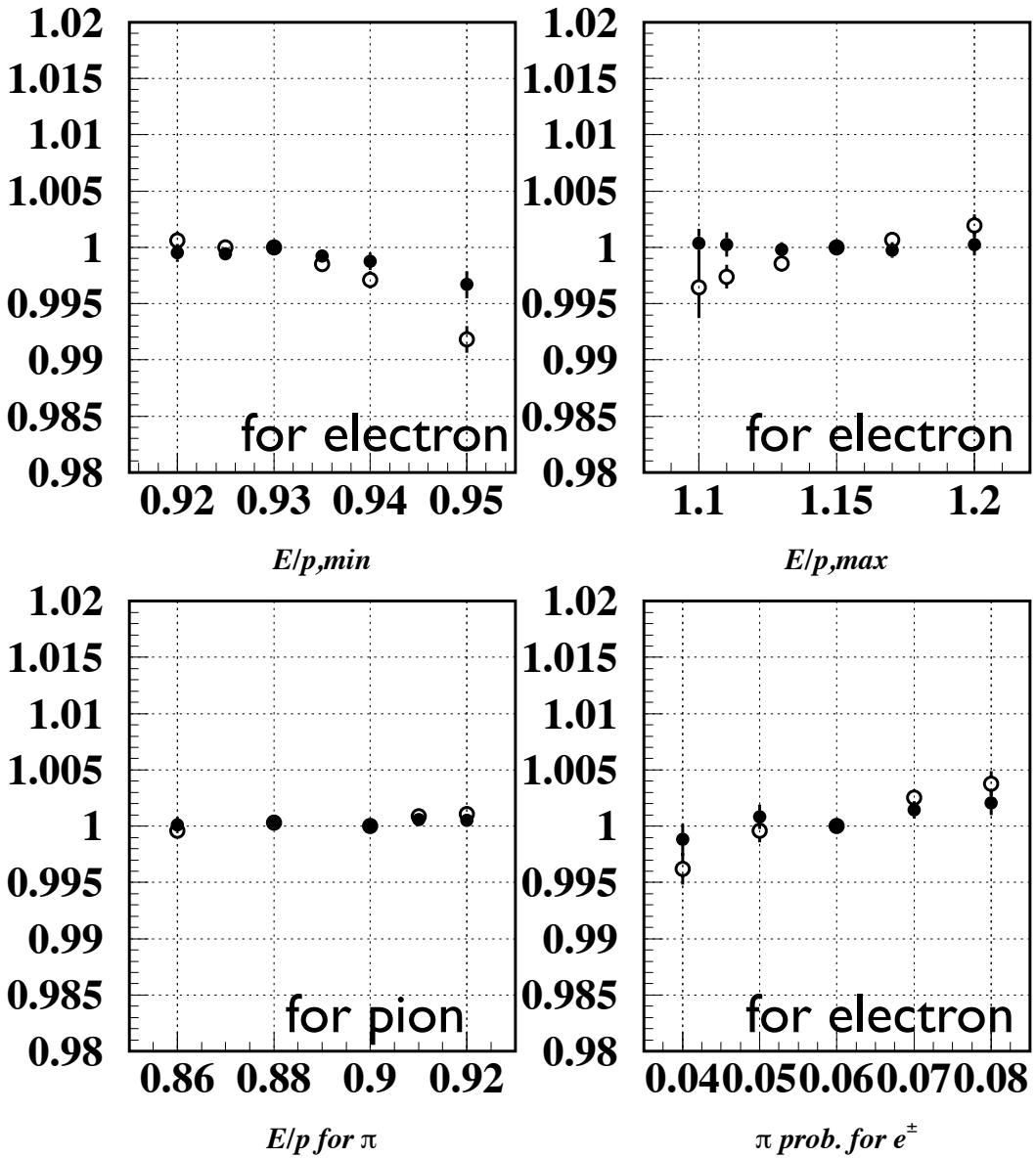
Cut variations about the fiducial region





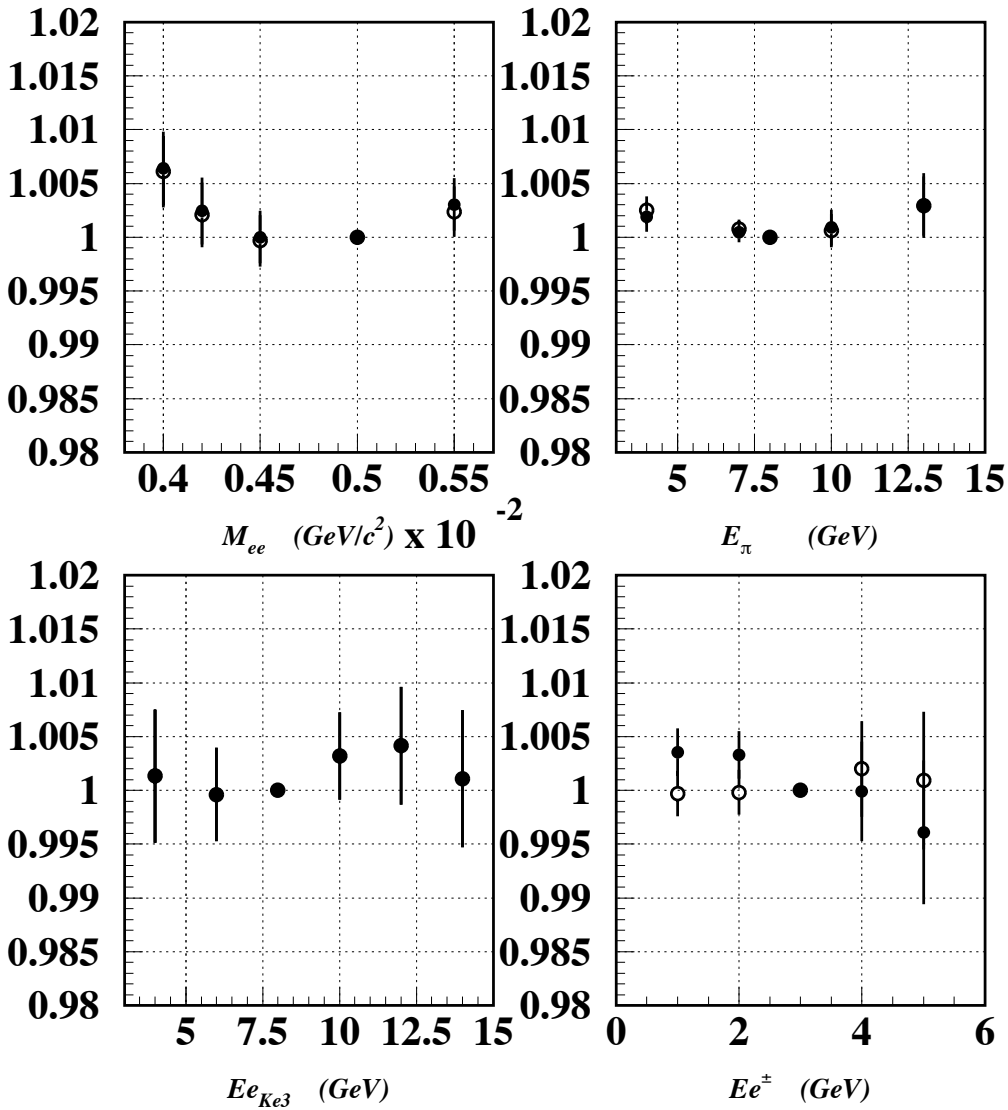
- Lower limit of E_K is removed
- Both max. and min. soln. for E_K are restrict under 200 GeV

Cut variations about π-e rejection cuts



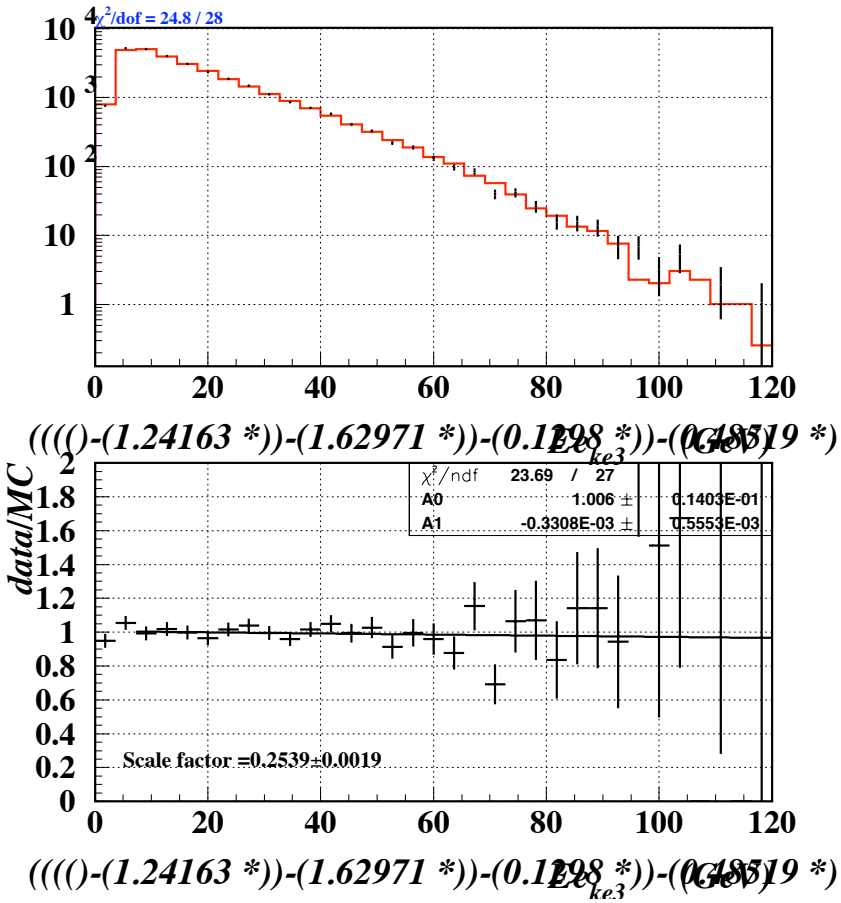
Cut variations about energy spectra and M_{ee}

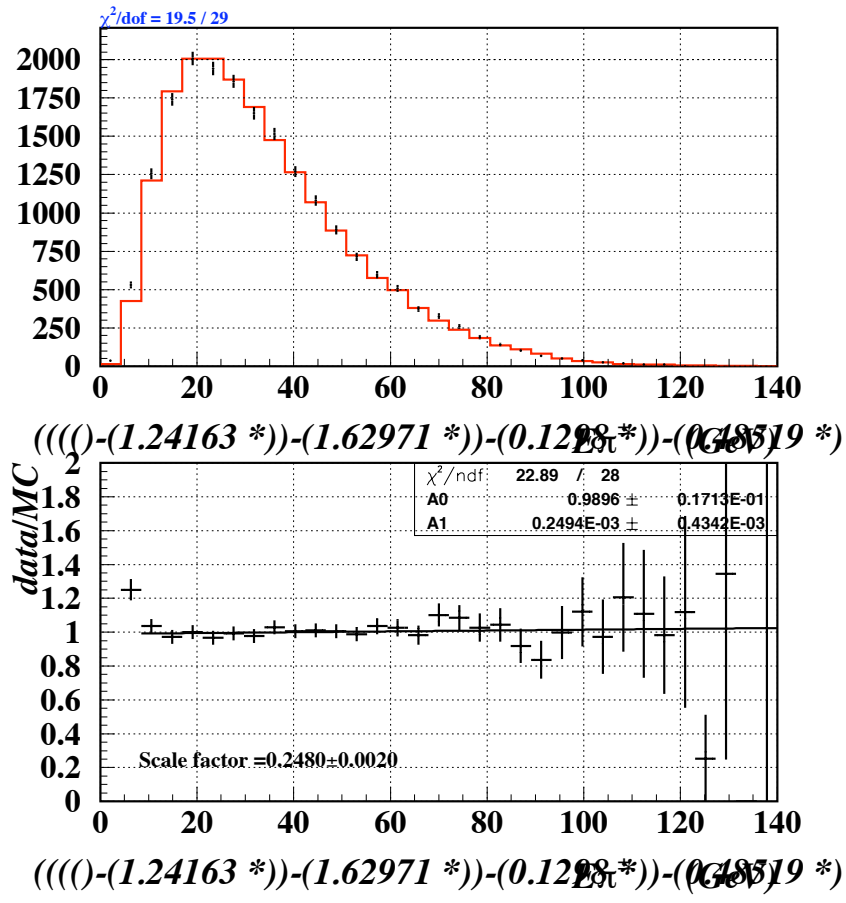
MC Ke3ee has cutoff value Mee>0.004 GeV/c^2



Data (BG subtracted)/MC comparison

Energy of $e^{\pm}_{ke3}$ and $\pi^{\pm}$

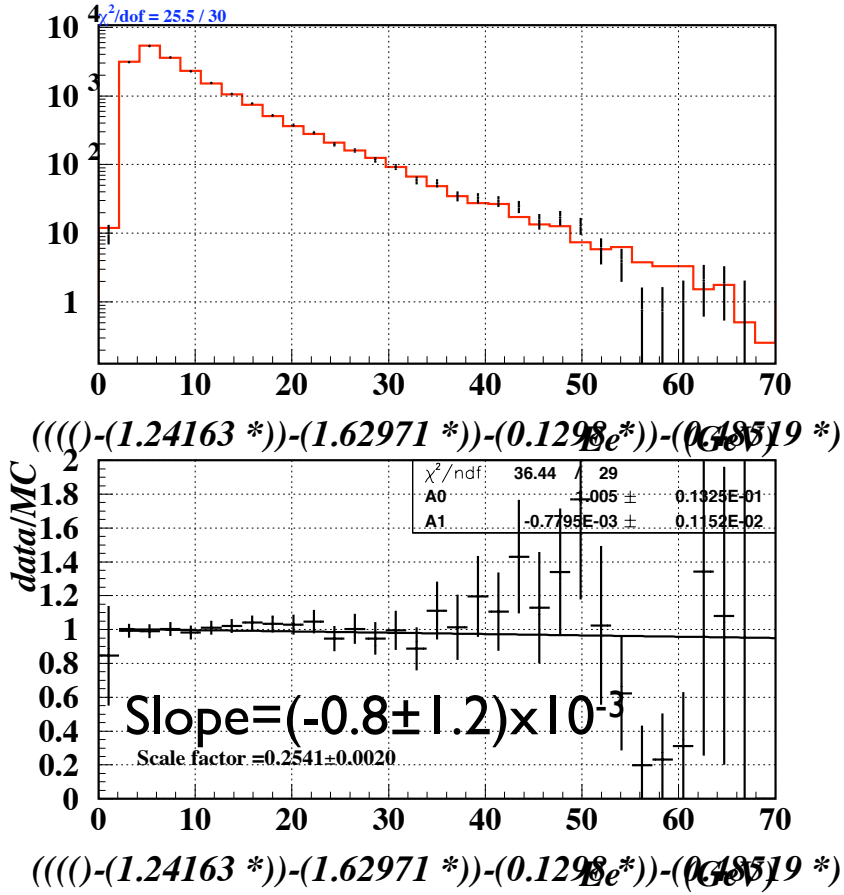




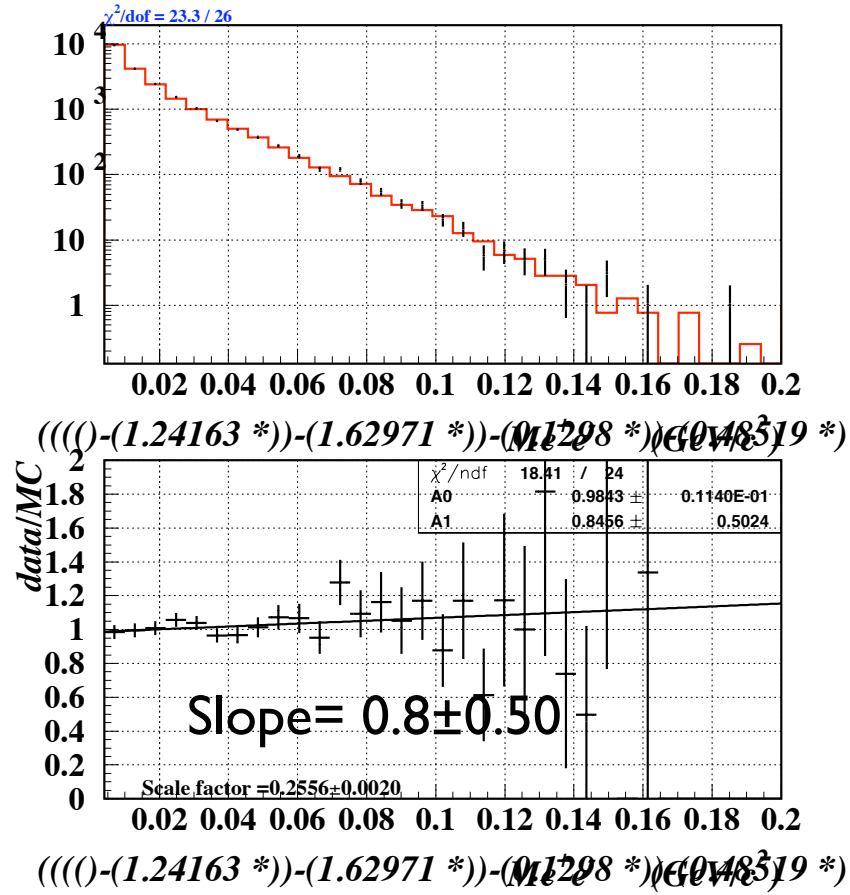
$Ee^{\pm}_{ke3}$ (GeV) $E\pi^{\pm}$ (GeV)

Data (BG subtracted)/MC comparison

Energy of $e^{\pm}_{pair}$ and $Me^{+}e^{-}$

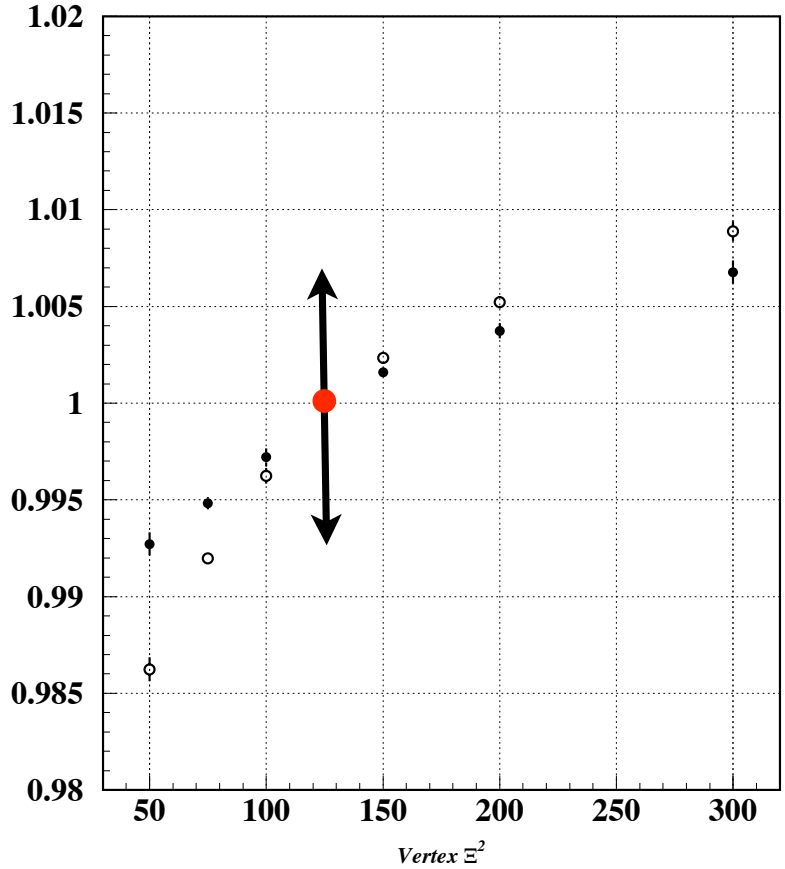


$e^{\pm}_{pair}$

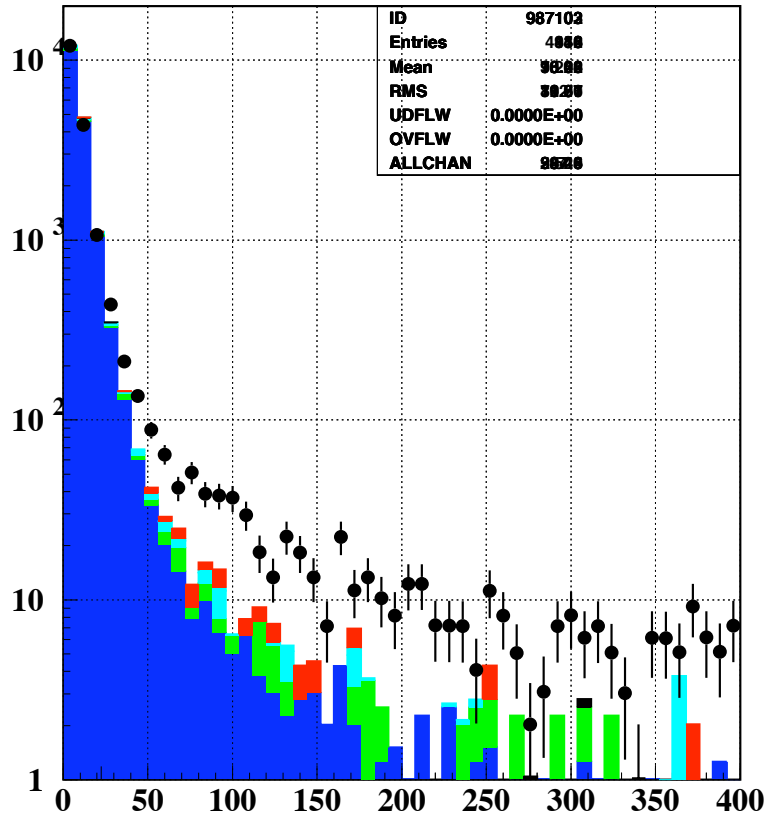


$Me^{+}e^{-}$

Cut variation on vertex χ^2



vertex χ^2



vertex χ^2

Cut variation is dominated by this uncertainty (0.75%)

Cut variation error total = 0.82%

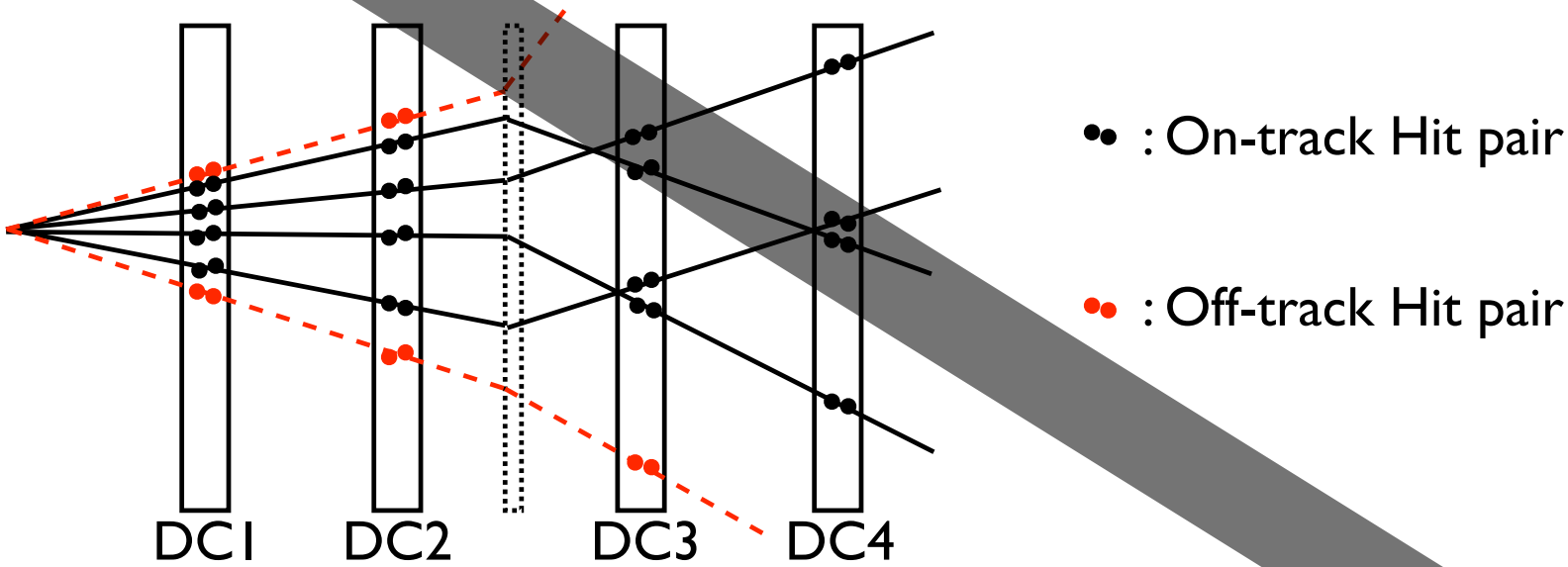
Correction and error(%)

			error(%)	
Statistic			1.01	
Systematic				
	cut variation		0.82	
	π ineff. (E/p)	δ=0.72	0.05	
	π loss in TRD	δ=2.91 (2.24,Signal) (2.58,norm.)	0.59	
	e ineff.(E/p)	δ= 0.39	0.10	
	Radiative corr.	δ= 2.1	0.1	
	Systematic Total(internal)		1.02	
	Systematic (external)		2.84	
Systematic Total			3.02	

This rejection is removed, because MC does not simulate well about near cell hit.

$K_L \rightarrow \pi^+\pi^-\pi^0_{4e}$ rejection

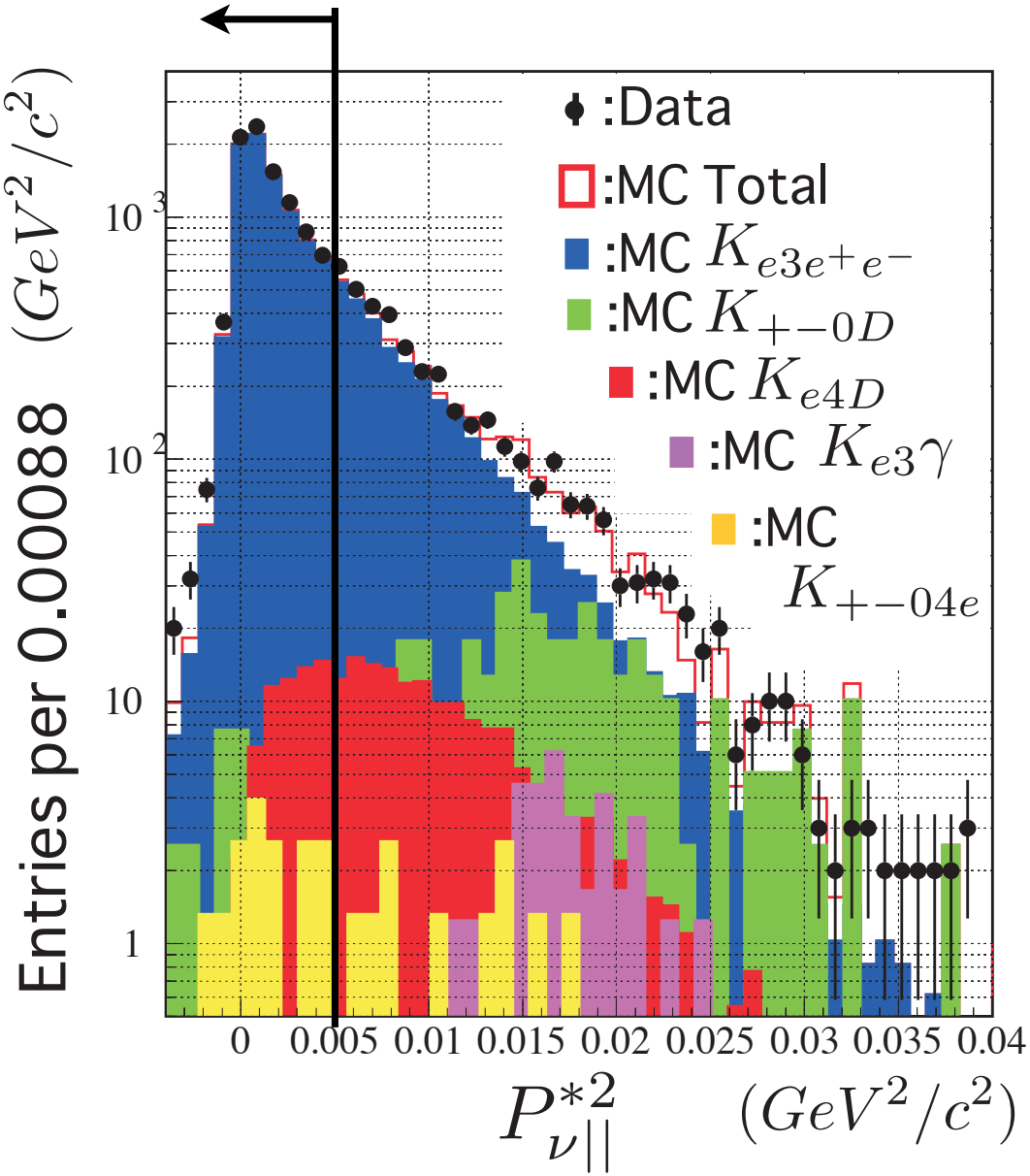
Off-track In Time Pair Rejection



Signal : 13.3% of events are rejected.

pm04e : 75.0% of events are rejected.

Cross check by small BG region



Observed events and estimated BG

	without $P_{\nu\|\|}^{*2}$ cut	$P_{\nu\|\|}^{*2}$<0.005(GeV^2/c^2)
Ke3ee(with BG)	19466 evts	16348 evts
$K_L \rightarrow \pi^+\pi^-\pi^0_D$	576.8 evts	174.1 evts
$K_L \rightarrow \pi^\pm e^+\nu\ \pi^0_D$	287.0 evts	124.3 evts
$K_L \rightarrow \pi^\pm e^+\nu\ \gamma$	132.0 evts	101.0 evts
$K_L \rightarrow \pi^+\pi^-\pi^0_{4e}$	204.3 evts	4.4 evts
$\Xi \rightarrow \Lambda\ \pi^0_D$	1.7 evts	0.3 evts
Double Ke3	29.1 evts	21.4 evts
N/S	7.7%	2.6%
BR[Ke3ee]	$(1.650\pm0.053)\times10^{-5}$	$(1.644\pm0.054)\times10^{-5}$

Ke3ee Branching fraction

$[1.650 \pm 0.027(\text{stat}) \pm 0.050] \times 10^{-5}$

$M_{e^+e^-} > 0.005\ \text{GeV}/c^2$