Branching Fraction of Ke3ee

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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

50 < EKaon(max), EKaon(min)* < 140 GeV	
95 < VertexZ < 150 m	
Vertex χ^2 < 100	
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
$M\pi^{\pm}e^{\mp}e^{+}e^{-}$ < 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	$E\pi^{\pm}$ > 10 GeV (for one $\pi^{\pm}$)

* Due to two ambiguity from neutrino, This requires $P_{\nu||}^{*2} > 0$

Background

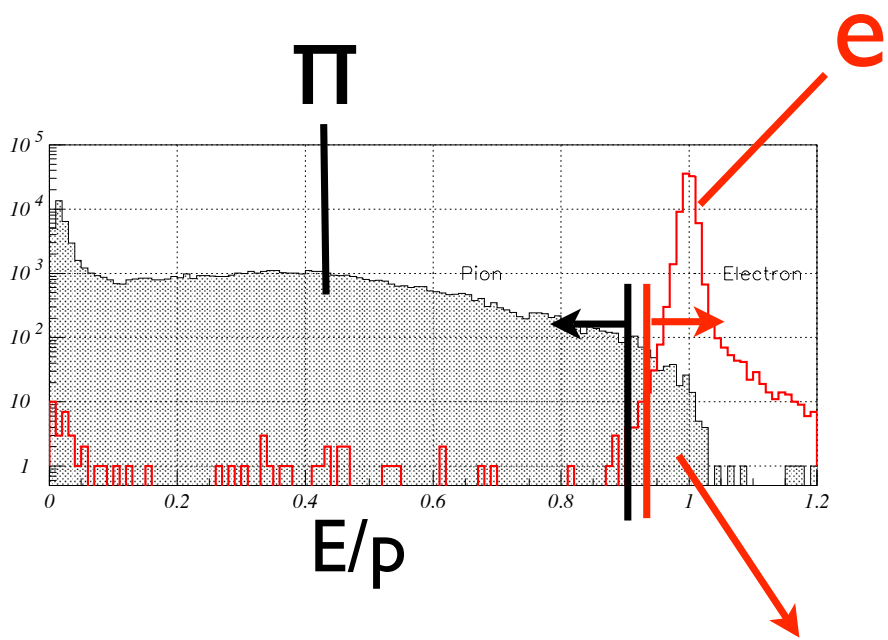
- $K_L \rightarrow \pi^+\pi^- \pi^0_D$
  $(\pi^0 \rightarrow e^+e^-\gamma)$
  $\downarrow$
  One $\pi^\pm$ fakes $e^\pm$
- $K_L \rightarrow \pi^\pm e^+\nu\ \pi^0_D$
  $(\pi^0 \rightarrow e^+e^-\gamma)$
- $K_L \rightarrow \pi^\pm e^+\nu\ \gamma$
  ($\gamma \rightarrow e^+e^-$: external conversion)
- $K_L \rightarrow \pi^+\pi^- \pi^0_{4e}$
  $(\pi^0 \rightarrow e^+e^-e^+e^-)$

Monte Charlo

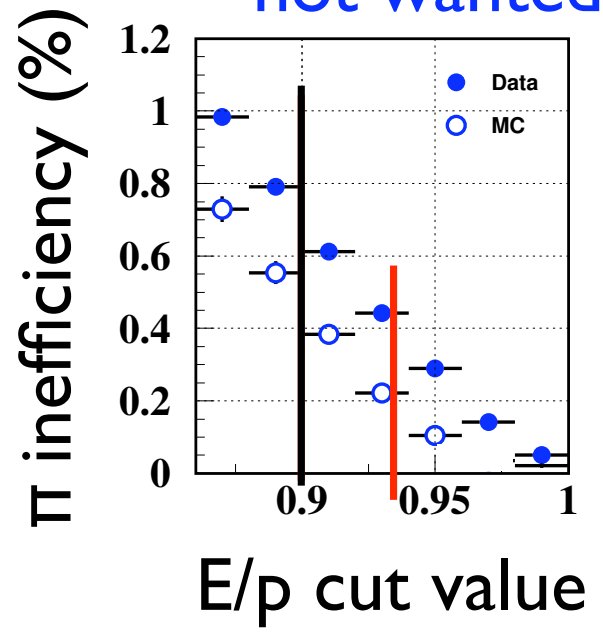
- Ke3ee ChPT (p^4) by Kentaro Tsuji, Student of Osaka university
- $K_L \rightarrow \pi^+\pi^-\pi^0{}_D$ KTeV MC default
- $K_L \rightarrow \pi^\pm e^+\nu\ \pi^0{}_D$ KTeV MC default
- $K_L \rightarrow \pi^\pm e^+\nu\ \gamma$ KTeV MC default + External conversion
- $K_L \rightarrow \pi^+\pi^-\pi^0{}_{4e}$ KTeV MC default

Background $K_L \to \pi^+\pi^- \pi^0_D$

One $\pi^\pm$ fakes $e^\pm$ (E/p)

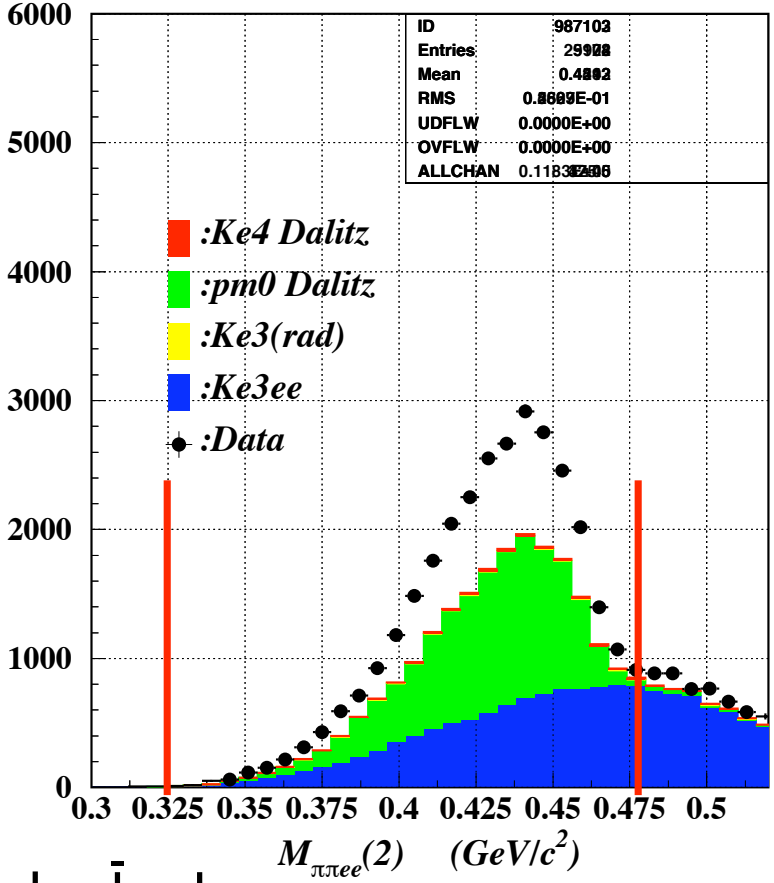


$K_L \to \pi^+\pi^- \pi^0, \pi^0 \to \gamma\gamma$
event selection only $M_{\pi\pi\gamma\gamma}$
not wanted E/p



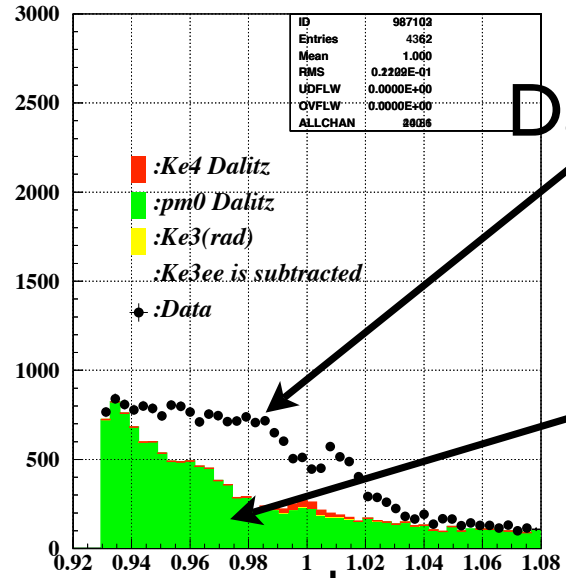
0.4% $\pi^\pm$ fakes $e^\pm$ by E/p cut at 0.93

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



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

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



Data-Signal

MC pm0d

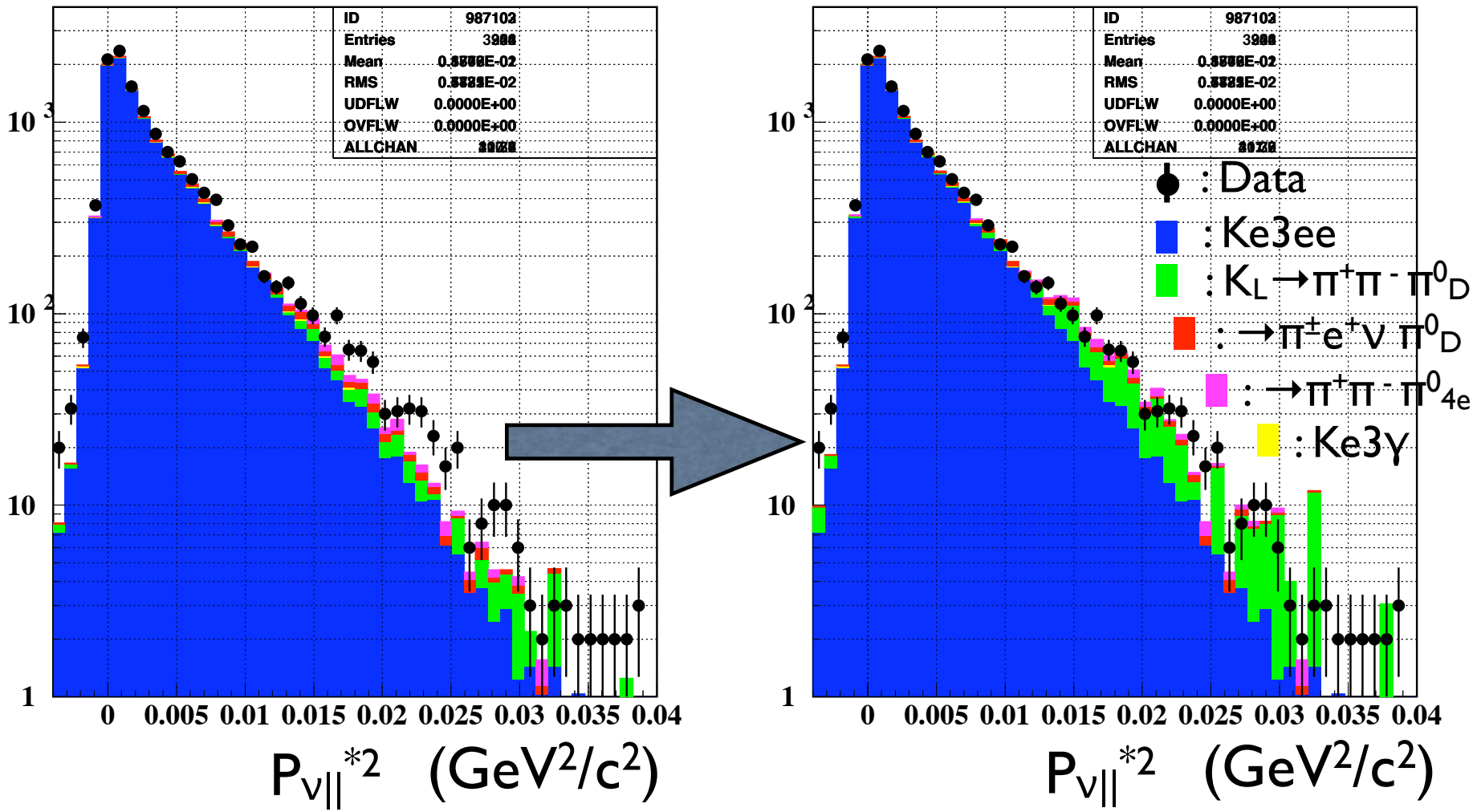
E/p for $\pi^{\pm}$ fake $e^{\pm}$

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

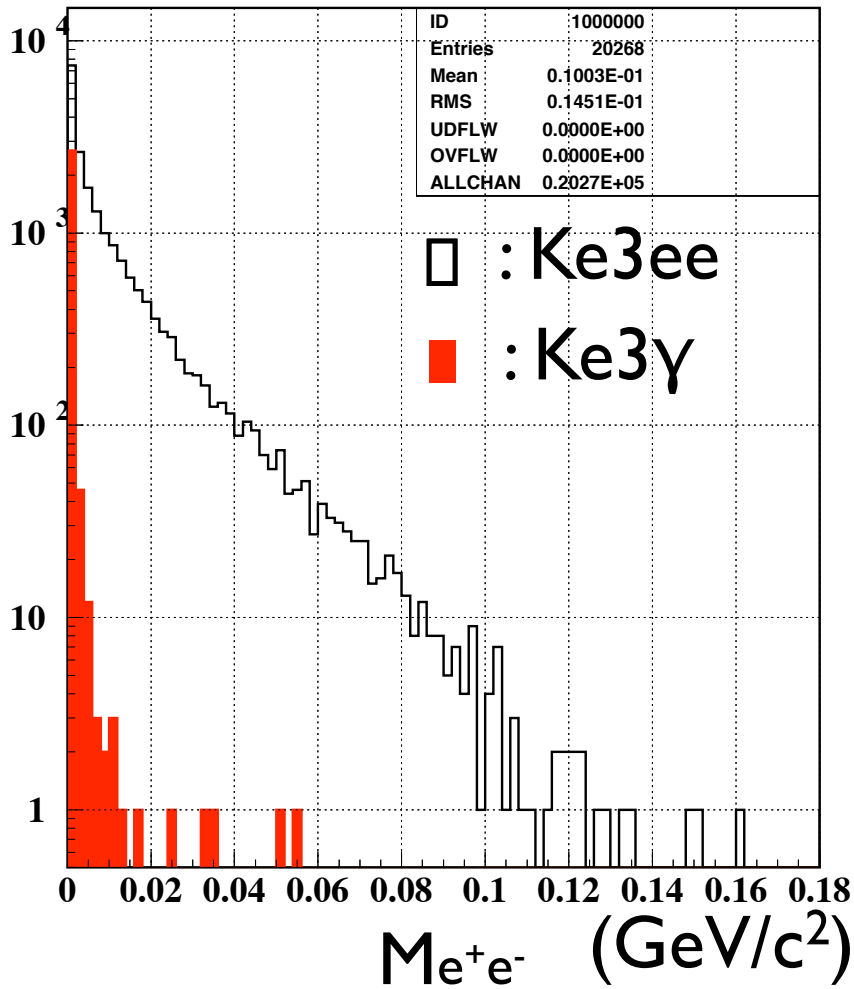
Same way on TRD

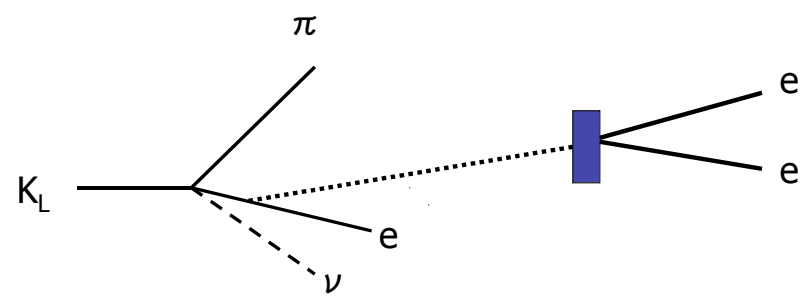
Factor must be 5.4±0.4, totally

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



Separation from ext. conversion evt.



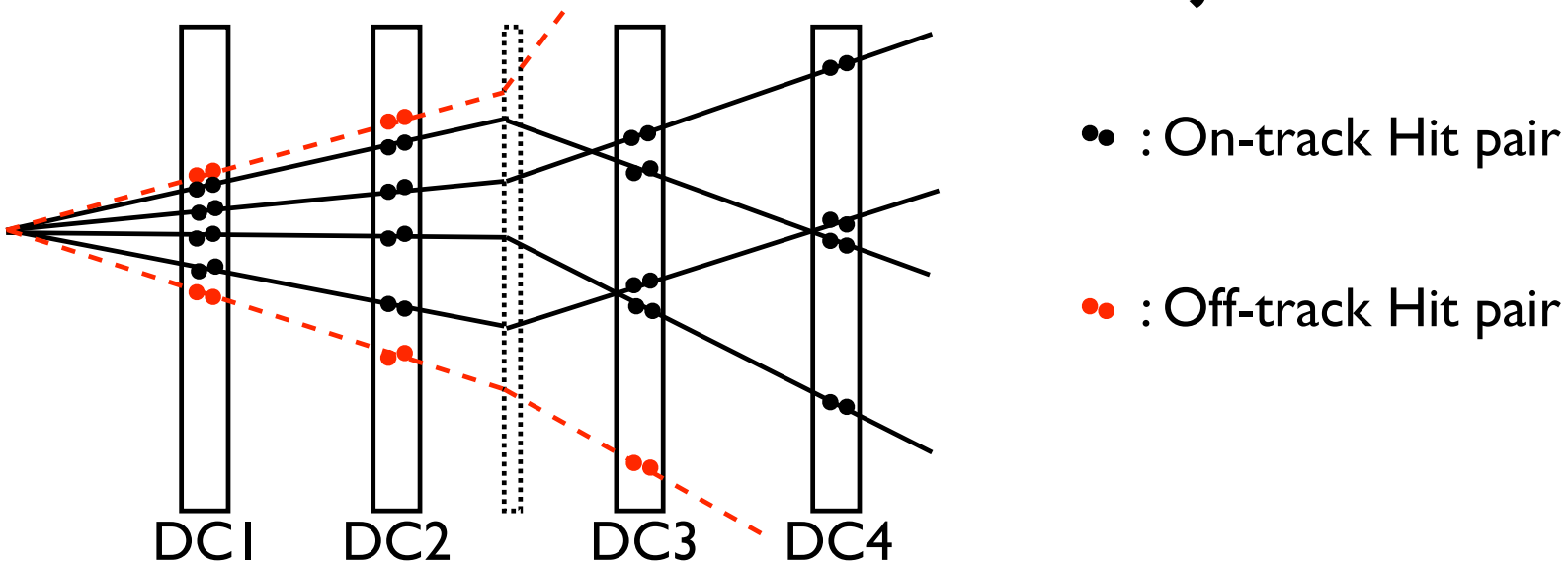


Mee cut
,>5 MeV, reduces

- 54.3% of data
- 99.3% of Ke3γ with external conversion

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

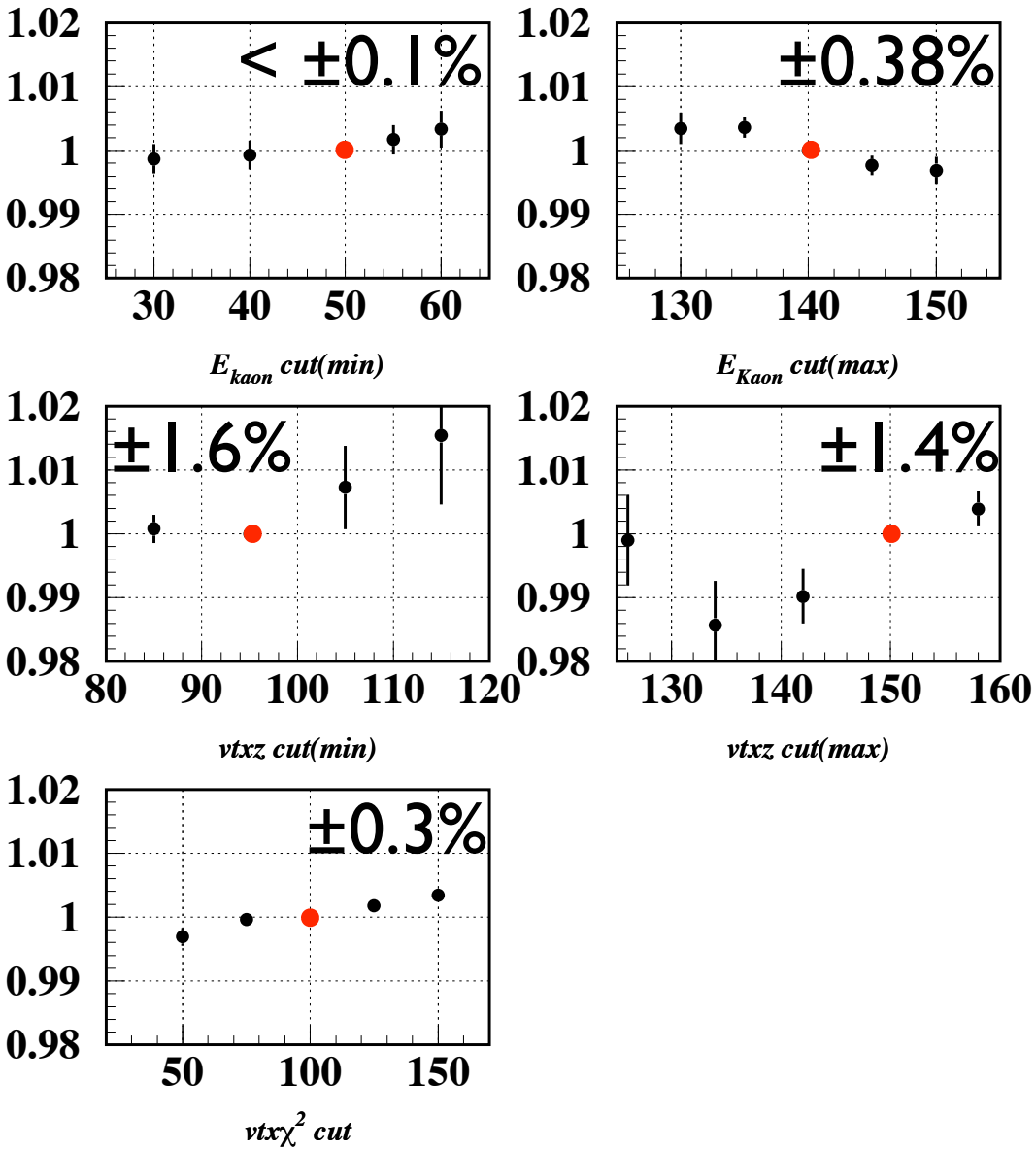
Off-track In Time Pair Rejection



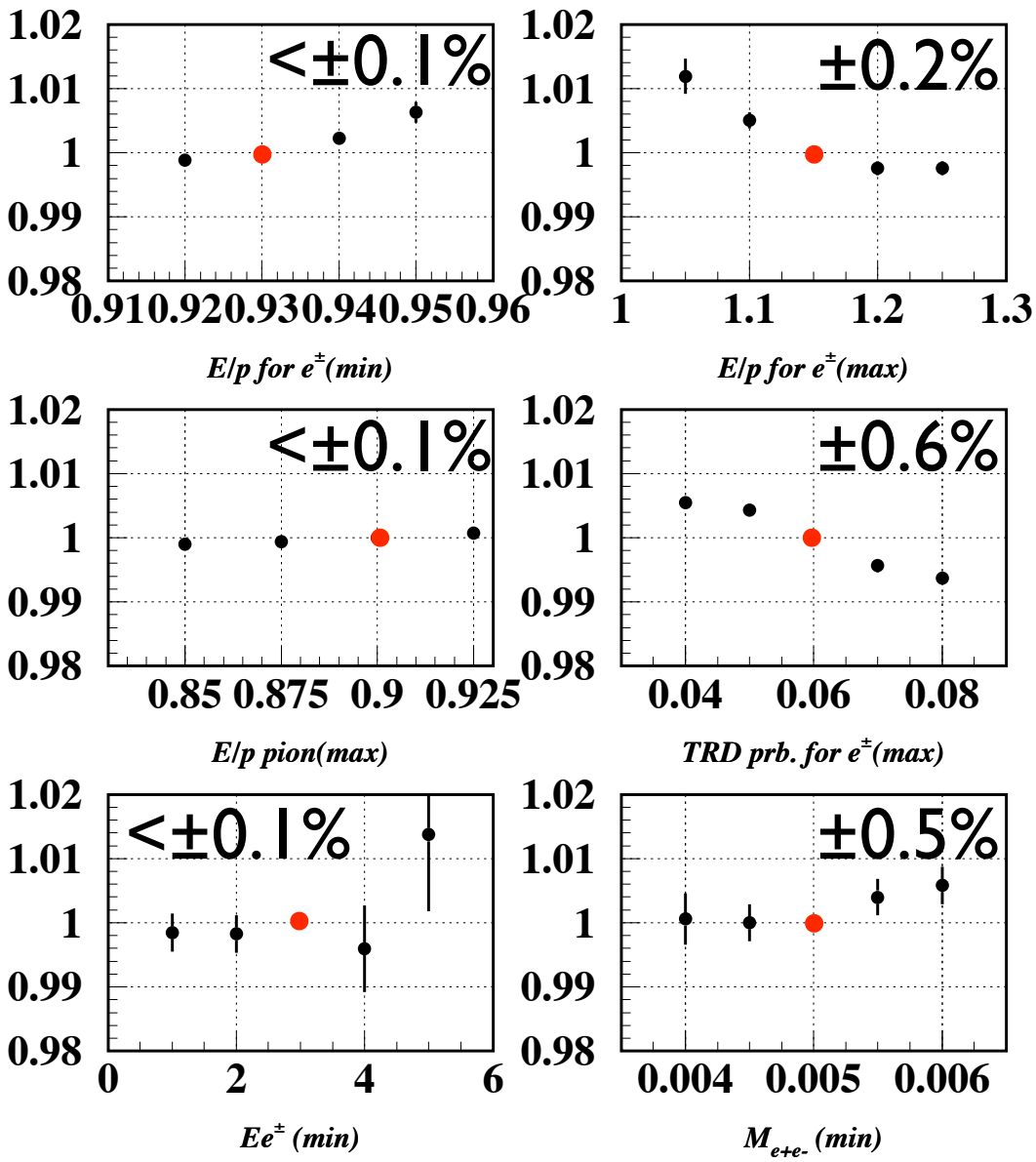
Signal : 13.3% of events are rejected.

pm04e : 75.0% of events are rejected.

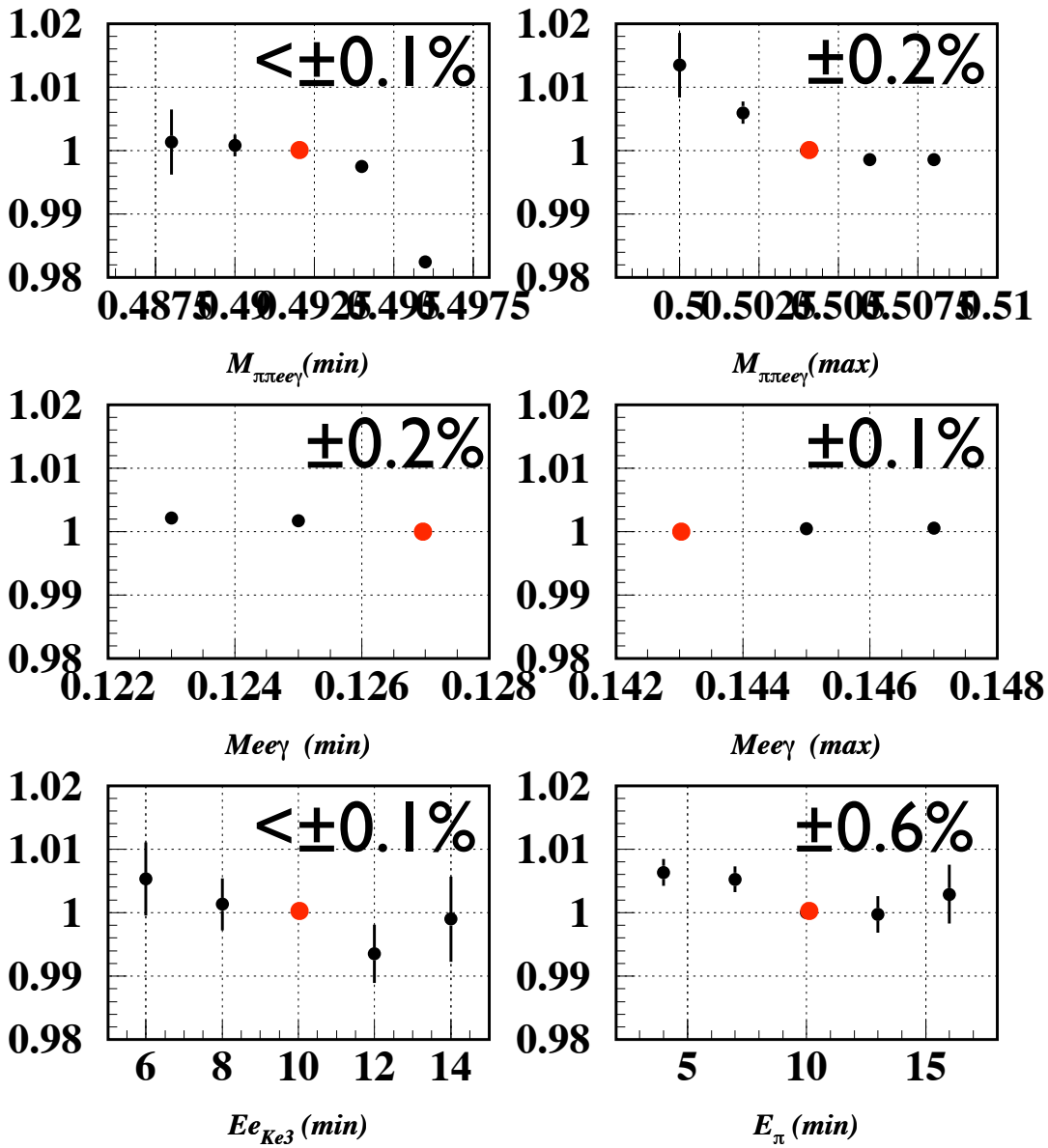
Error due to cut variations(1)



Error due to cut variations(2)



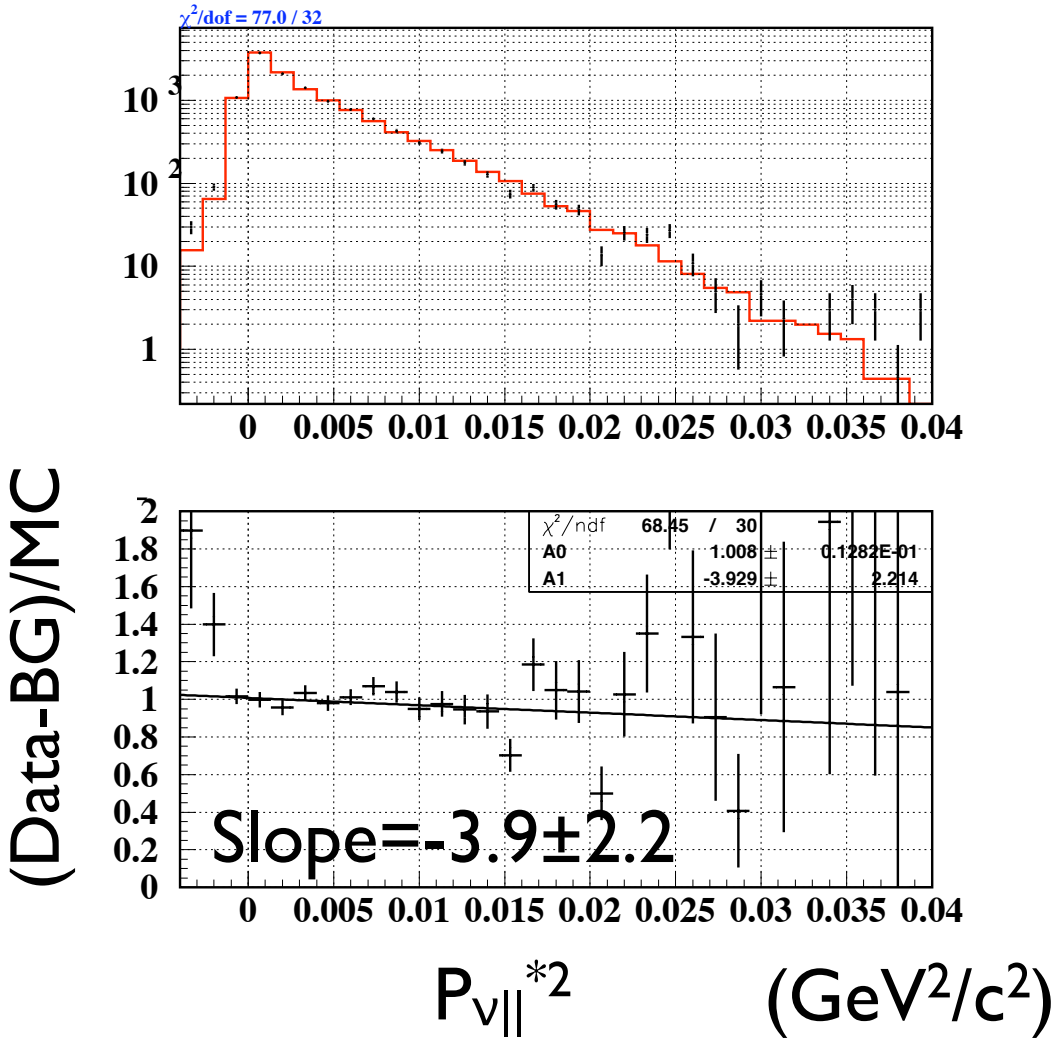
Error due to cut variations(3)



Total error due to cat variations (excepting TRD cut):

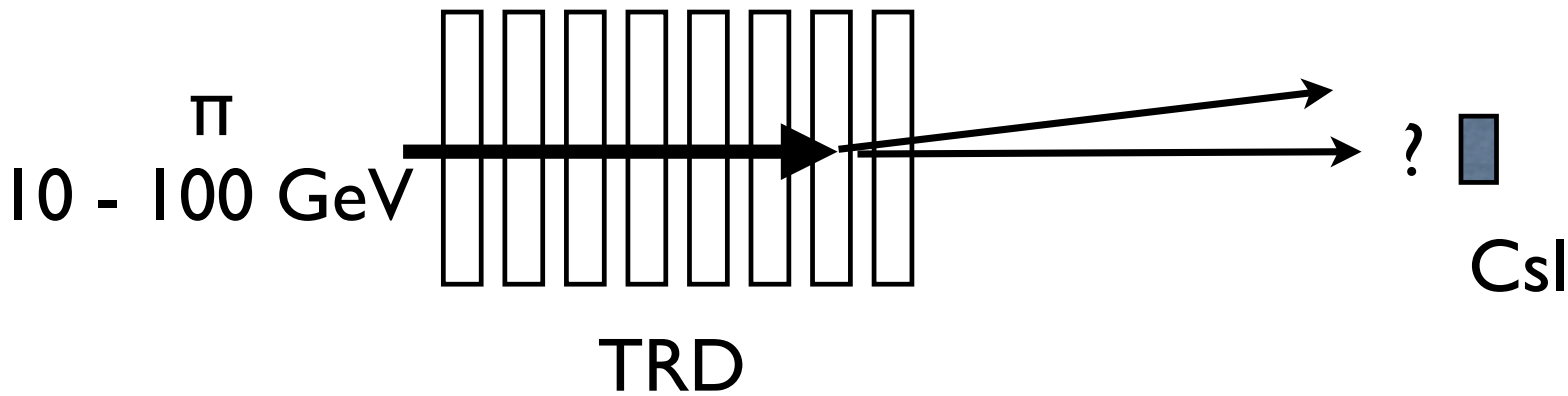
2.4%

A comparison of kinematic distribution between data-MC



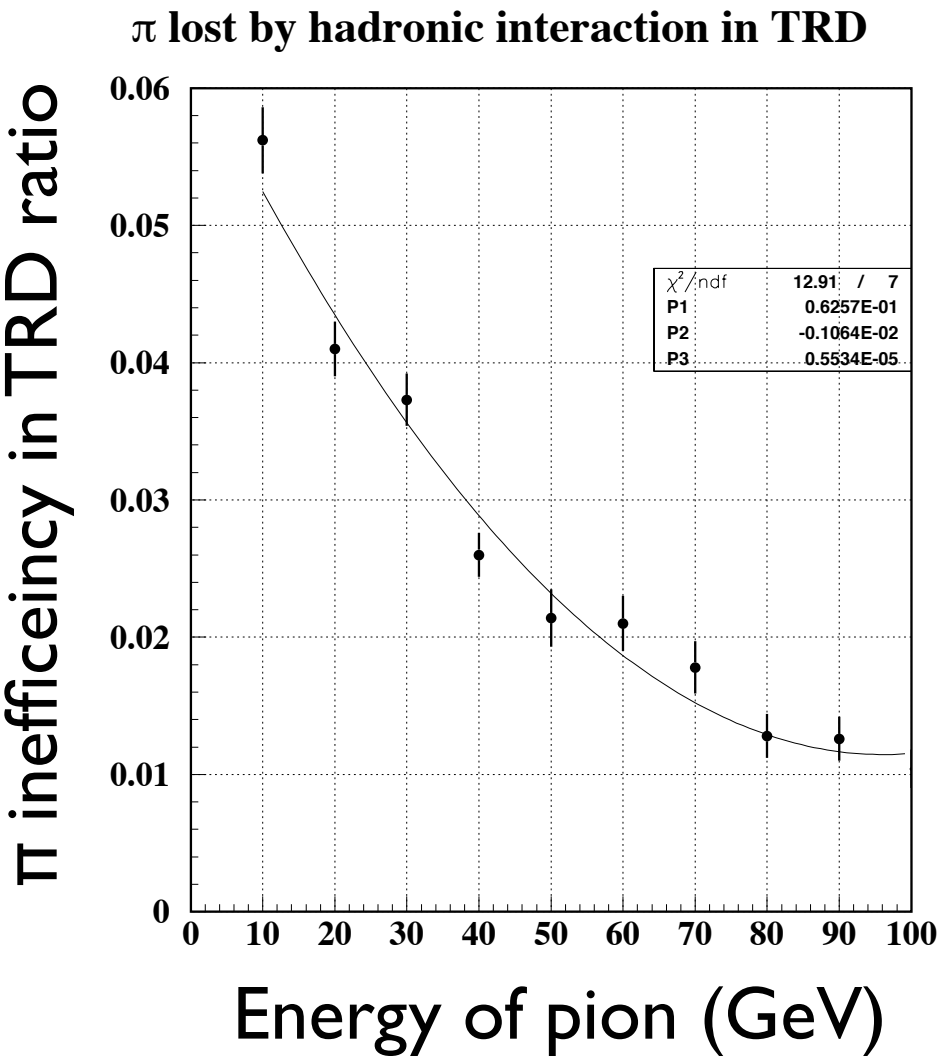
Pion inefficiency in TRD

GTeV Simulation



How meny events hit the CsI counter ?
Cross section 10cm×10cm

Pion inefficiency in TRD



Fitting function

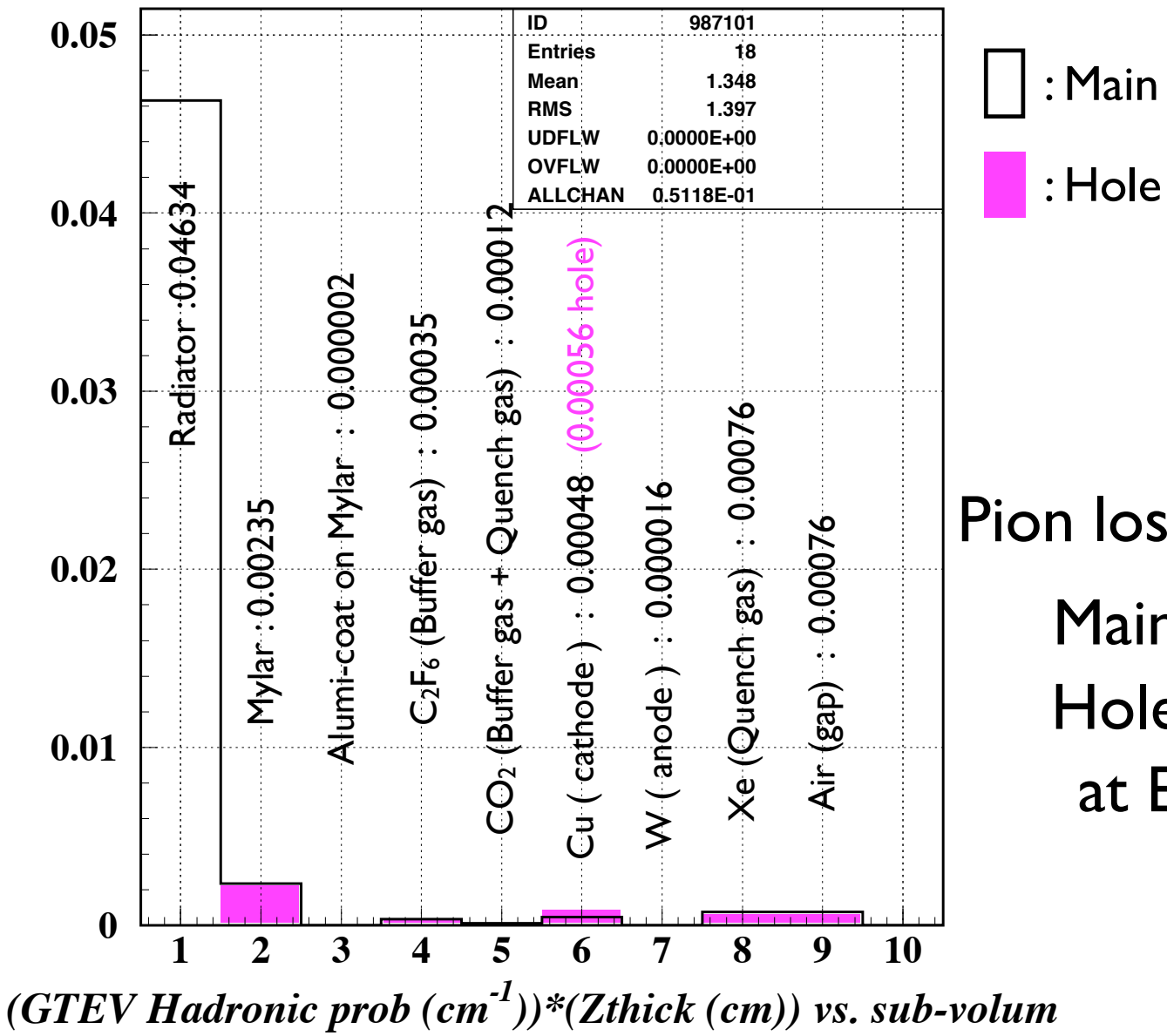
$P_{Lost}(Epi) = 0.062 - 0.00106\ Epi + 5.5\times10^{-6}\ Epi^2$

Event-weight =

$(1 - P_{Lost}) \times$ weight(Path)

Next slide

- Pion loss in TRD, if a pion goes along z axis.



: Main

: Hole

Pion loss ratio (Total)

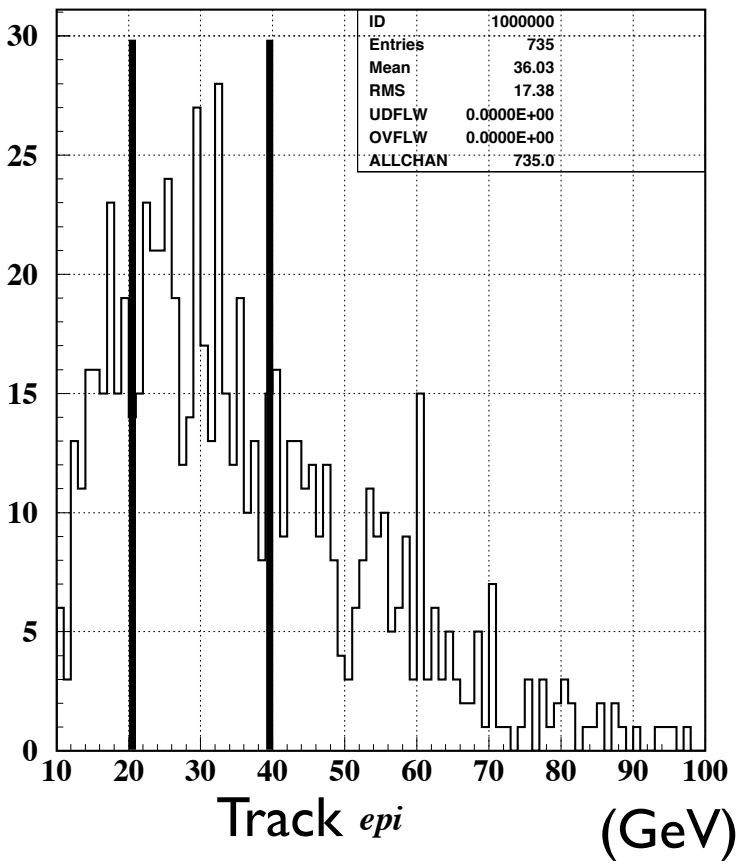
Main : 0.05118

Hole : 0.00493

at Epi =13.3 GeV

- Pion loss in TRD

Path of pion track through TRD



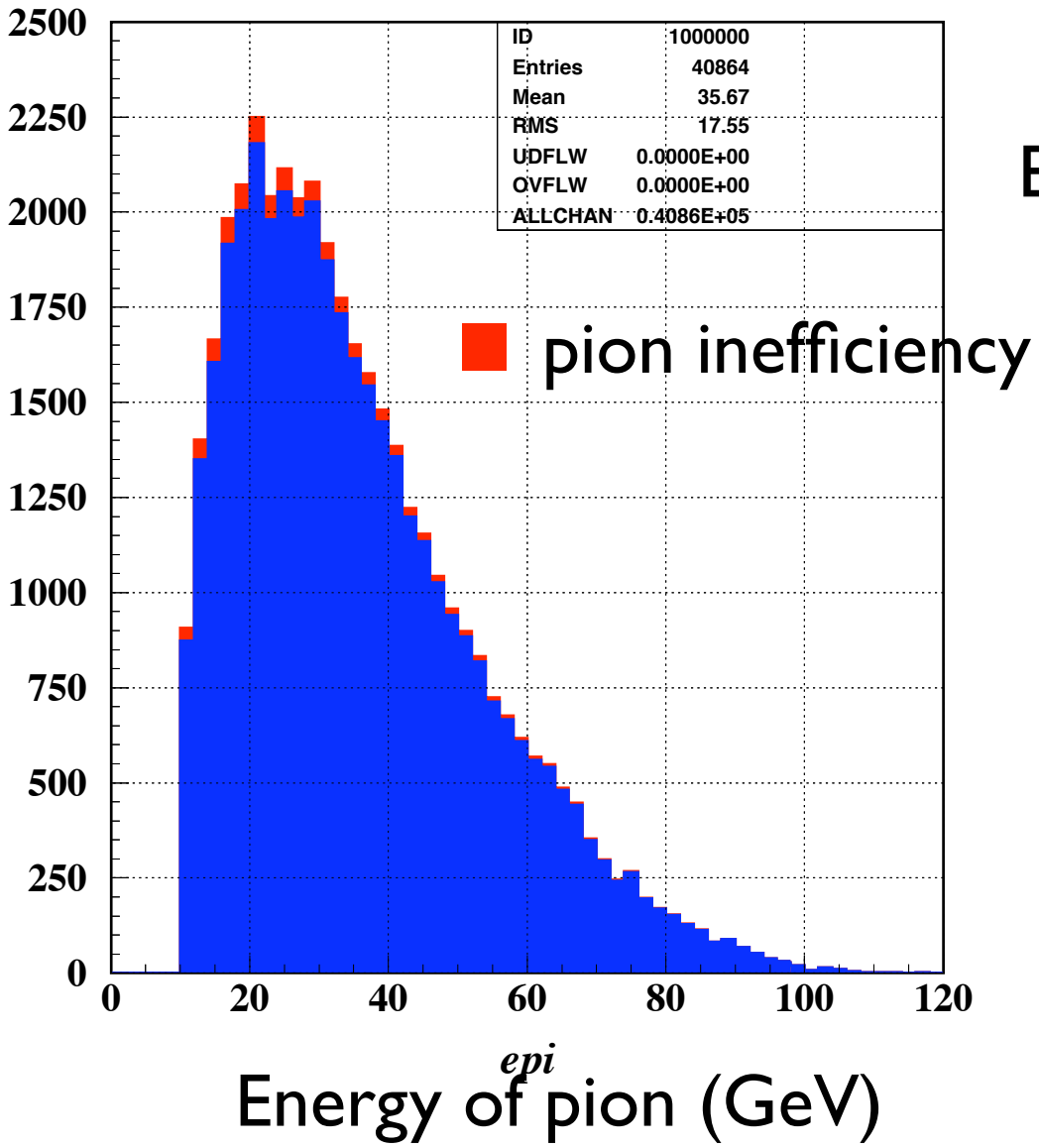
NZF024, 025, 026

	Ep<20	20<Ep<40	40<Ep
Main	1.684	1.536	1.346
Hole	0.564	0.713	0.904
Total	2.25	2.25	2.25
Hole/Total	25(%)	32(%)	40(%)

(m)

Main : length through outside of hole region
Hole : length through inside of hole region

Pion inefficiency in TRD



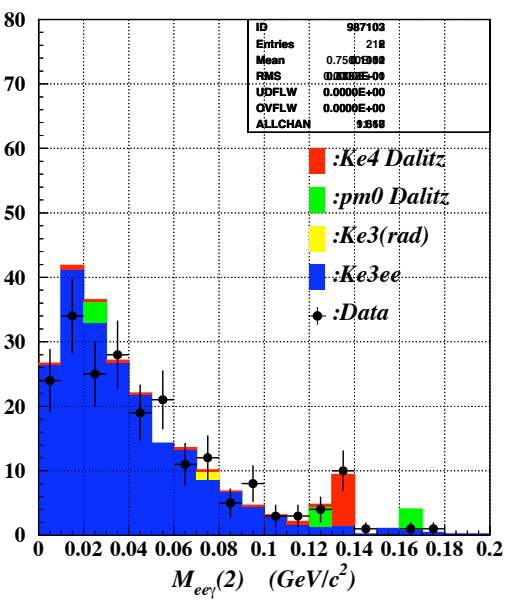
Event-weight =
$(1 - P_{Lost}) \times \text{weight(Path)}$

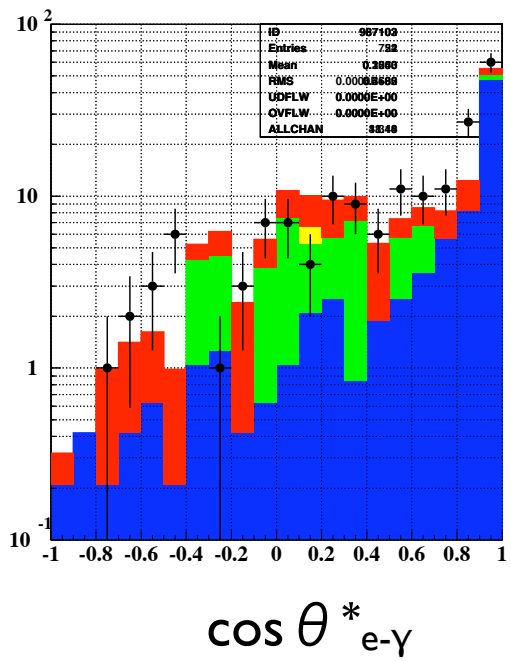
Total missing events:
(2.38±0.18)%

Radiative correction

Attached 'PHOTOS' ver.2.13 to MC generation

α_{QED}= 0.0073, $E_\gamma$cutoff = 0.5×10^{-4} MeV





Acceptance:

$$\frac{\text{1- with PHOTOS}}{\text{without PHOTOS}}$$

= 0.021±0.002

Branching Fraction

Estimated Background and ovserved Ke3ee:

	$P_{\nu ll}^{*2}$:Free	$P_{\nu ll}^{*2}$<0.005(GeV^2/c^2)
Ke3ee(ovserved)	17089(withBG)	11426 (withBG)
$K_L \rightarrow \pi^+\pi^-\pi^0_D$	868.5	75.8
$K_L \rightarrow \pi^\pm e^+\nu\ \pi^0_D$	280.5	79.3
$K_L \rightarrow \pi^\pm e^+\nu\ \gamma$	48.8	25.1
$K_L \rightarrow \pi^+\pi^-\pi^0_{4e}$	61.2	-
N/S	7.3%	1.6%
Br[ke3ee]	1.709	1.722
Norm.(prescale 4)	244645	
MC Norm.	671502	

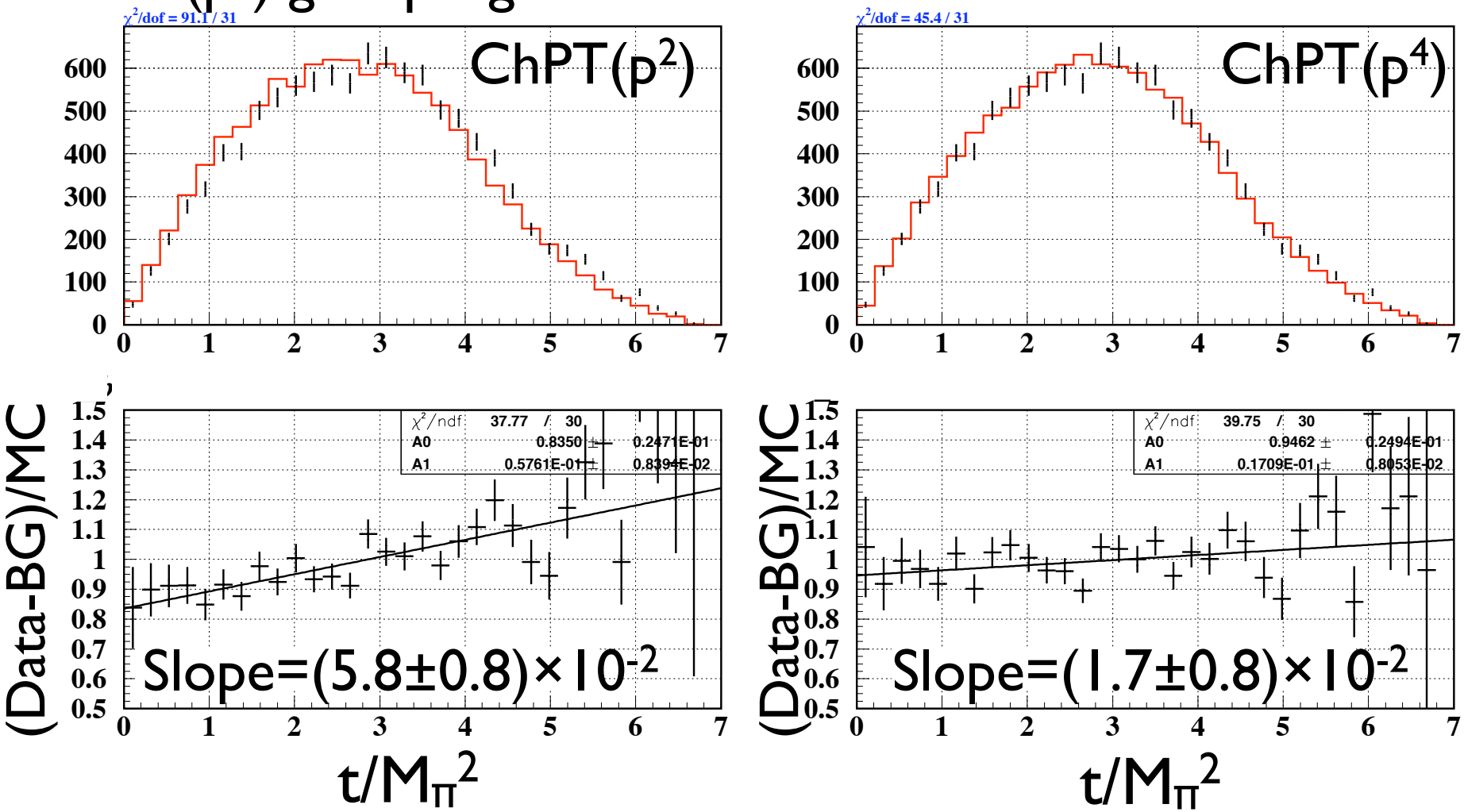
This study

$(1.709 \pm 0.023_{(stat)} \pm 0.061_{(sys)}) \times 10^{-5}$

(0.054: from Br[$K_L \rightarrow \pi^+\pi^-\pi^0_D$])

ChPT (p^4)

$(1.61) \times 10^{-5}$ By K.Tsuji Osaka-U

Evaluation of ChPT (p^4)

- ChPT(p^4) gets progress on Kaon structure