Recent Works on 2002 $\pi\nu\bar{\nu}(1)$ Analysis

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1 $T \cdot 2 \cdot IC$ Efficiency Measurement

How to measure it?

- $Kbeam$ Monitor processed by a special PASS2 code.
  $\Rightarrow$ Reconstruct a track without T and 2 counter hit.
- 3rd layer hit is used as a '*reference time*',
  - *if* $|T_{T\cdot 2} - T_{layer3}| < 10$ *ns* $\Rightarrow T \cdot 2$ *hit,*
  - *otherwise* $\Rightarrow$ *No* $T \cdot 2$ *hit.*
- *Select* $K_{\mu 2}$*-like or* $K_{\pi 2}$*-like events from the sample,*
  $\Rightarrow T \cdot 2 \cdot IC$ *efficiency in each case,*
  $\Rightarrow T \cdot 2 \cdot IC$ *efficiency in* $\pi\nu\bar{\nu}$.

Result in the previous measurement

	$K_{\mu 2}$	$K_{\pi 2}$
$\epsilon T \cdot 2 \cdot IC$	0.8615 $\pm$ 0.0032	0.9302 $\pm$ 0.0025
Counter inefficiency	4.10%	3.98%
Gap inefficiency	9.75%	3.00%

- Why so small eff. in $K_{\mu 2}$?
- A discrepancy in Gap ineff. between $K_{\mu 2}$ and $K_{\pi 2}$?

First Try: Same setup cut as in the previous study

Cut	$K_{\mu 2}$	$K_{\pi 2}$
ALL	678536	190476
BAD_RUN	678153	190373
BAD_STC	677016	189398
RD_TRK	677016	189398
TRKTIM	677016	189398
UTC/RANGE	677016	189398
UTCQUAL	283084	72709
TARGET	279954	70482
COS3D	269118	68159
B4DEDX	264250	66680
CPITRS	260911	65824
CPITAIL	260690	65768
$\|Z_{IC}\|$ <10cm	248533	60800
TIC	248024	60621
TIMCON	247200	60249
DELCO	127401	30367
CKTRS	122309	29373
CKTAIL	114080	27585
BWTRS	108801	26341
U/RPVTRS	106652	25756
TARGF	101596	24515
DTGTTP	101594	24515
RTDIF	100637	24310
TGQUALT	100637	24310
PIGAP	99413	23936
TGB4	93243	22492
KIC	90366	21916
TGGEO	85450	18374
B4EKZ	83669	17996
TGZFOOL	83669	17996
PV(noBV+BVL)	2995	-
FITPI	-	11218
KP2BOX	-	10215
KP2STOP	-	10157
RTOT40	2807	-
N$_{K_{\mu 2}}$ or N$_{K_{\pi 2}}$	2807	10157

Why does PV(noBV+BVL) have so large rejection, $\sim$ 28 ??

Try excluding RSPV...

Cut	$K_{\mu 2}$	$K_{\pi 2}$
ALL	678536	190476
BAD_RUN	678153	190373
BAD_STC	677016	189398
RD_TRK	677016	189398
TRKTIM	677016	189398
UTC/RANGE	677016	189398
UTCQUAL	283084	72709
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TGQUALT	100637	24310
PIGAP	99413	23936
TGB4	93243	22492
KIC	90366	21916
TGGEO	85450	18374
B4EKZ	83669	17996
TGZFOOL	83669	17996
PV(noBV+BVL+RD)	73015	-
FITPI	-	11218
KP2BOX	-	10215
KP2STOP	-	10157
RTOT40	61076	-
N$_{K_{\mu 2}}$ or N$_{K_{\pi 2}}$	61076	10157

R(PV) $\sim$ 1.2 $\Leftarrow$ Looks normal !

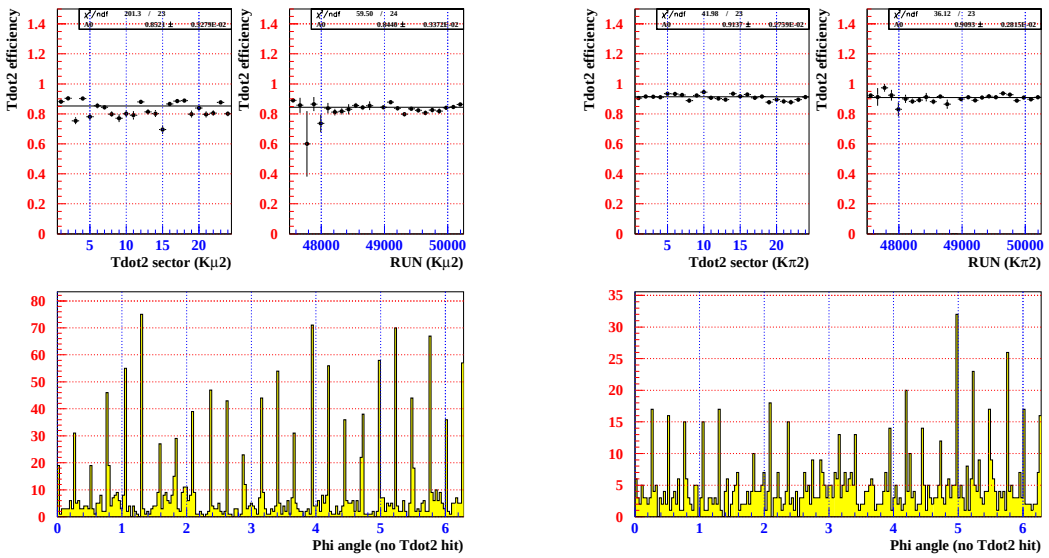
RSPV should not be applied in this case !!

Because...

- RSPV vetoes hits in counters except track counters
- T and 2 counters are excluded from track counter..

$\Rightarrow$ most $T \cdot 2$ hits are vetoed !!

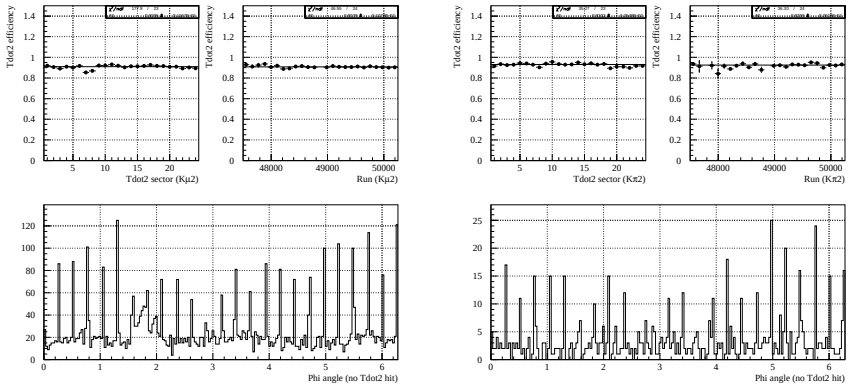
We lost most of normal events with $T \cdot 2$ hit !!



Inefficient events due to gap might be enhanced

This is why we see smaller counter ineff. in $K_{\mu 2}$

Then $T \cdot 2 \cdot IC$ efficiency looks like..



	$K_{\mu 2}$	$K_{\pi 2}$
$\epsilon T \cdot 2 \cdot IC$	0.9073 $\pm$ 0.0012	0.9233 $\pm$ 0.0027
Counter ineff.(good)	5.17%	3.35%
Counter ineff.(bad)	10.1%	4.86%
Gap ineff.	3.32%	3.57%

$K_{\mu 2}$ and $K_{\pi 2}$ are consistent now !

Some setup cuts are examined.

	$K_{\mu 2}$	$K_{\pi 2}$
# 1	0.9073 $\pm$ 0.0012	0.9233 $\pm$ 0.0027
# 2	0.9121 $\pm$ 0.0012	0.9270 $\pm$ 0.0026
# 3	0.9245 $\pm$ 0.0021	0.9354 $\pm$ 0.0045

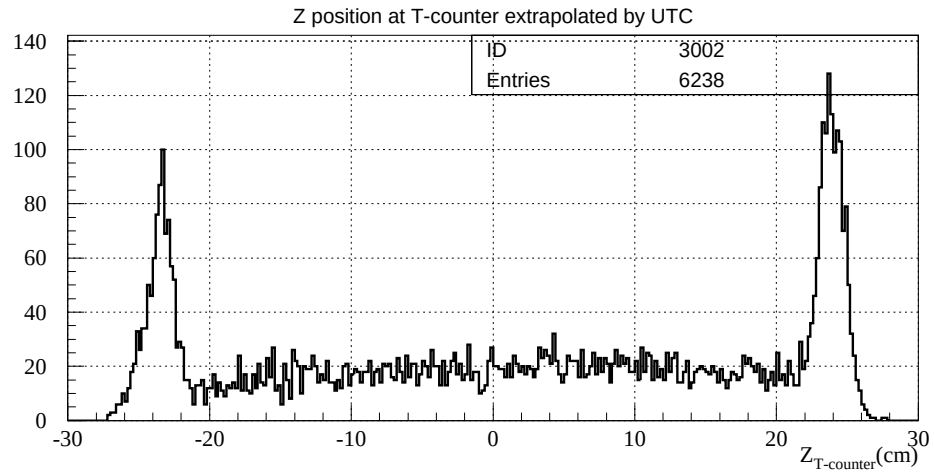
1 : setup cuts above

2 : # 1 + ICODEL14 + ZFRF + Layer>14(for $K_{\mu 2}$ only)

3 : # 1 + $|cos3d| < 0.2$ + $|Z_{IC}| < 5$ cm

Tighter Z cut $\Rightarrow$ Higher $T \cdot 2$ efficiency ??

Looking at $Z_{T-counter}$ distribution in 'no-$T \cdot 2$' events

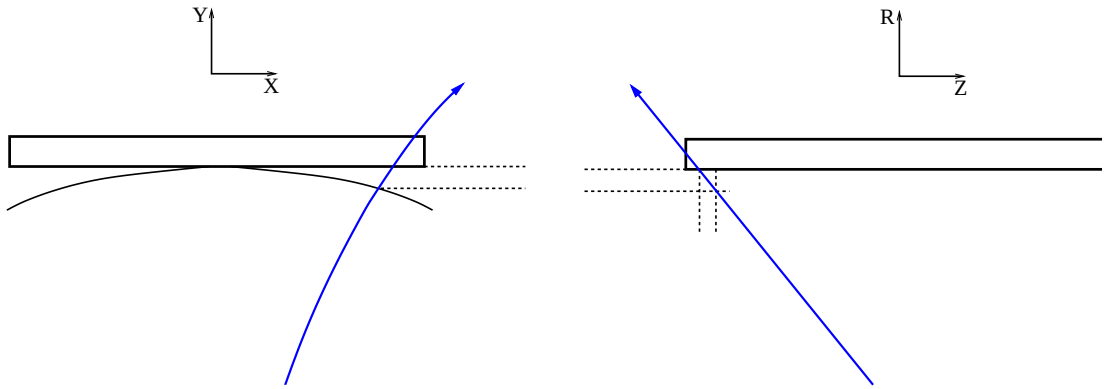


Strange peaks at the edge of T-counter...

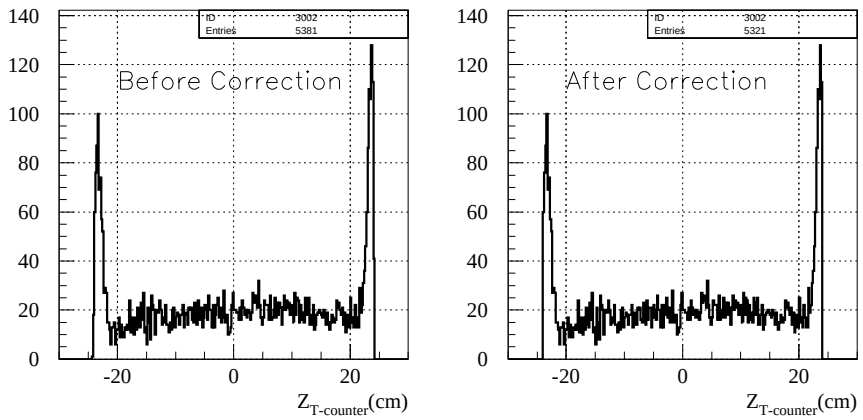
Some explanations to the peaks

1. 'flat_corr' correction ?
2. different alignments in counter by counter ?
3. contribution from some 'bad' counters ?
4. due to UTC fitting effect ?
5. T-counter really has inefficient region ??

1. 'flat_corr' correction ?



This 'flat_corr' correction was applied



$\Downarrow$

The peaks still exist.

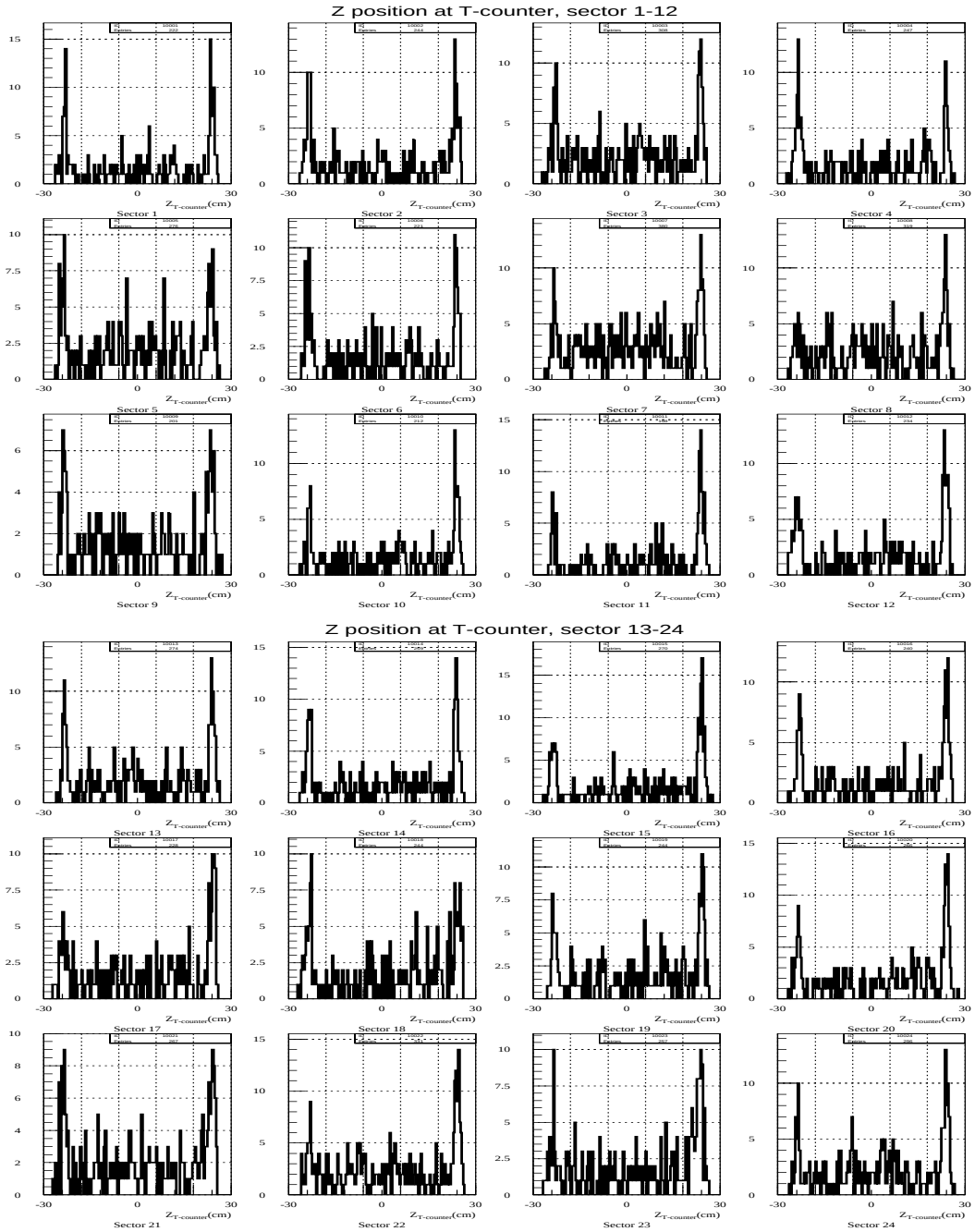
2. different alignments in counter by counter ?

descrepancy $\sim$ 2 mm

$\Downarrow$

this effect is too small..

3. contribution from some 'bad' counters ?

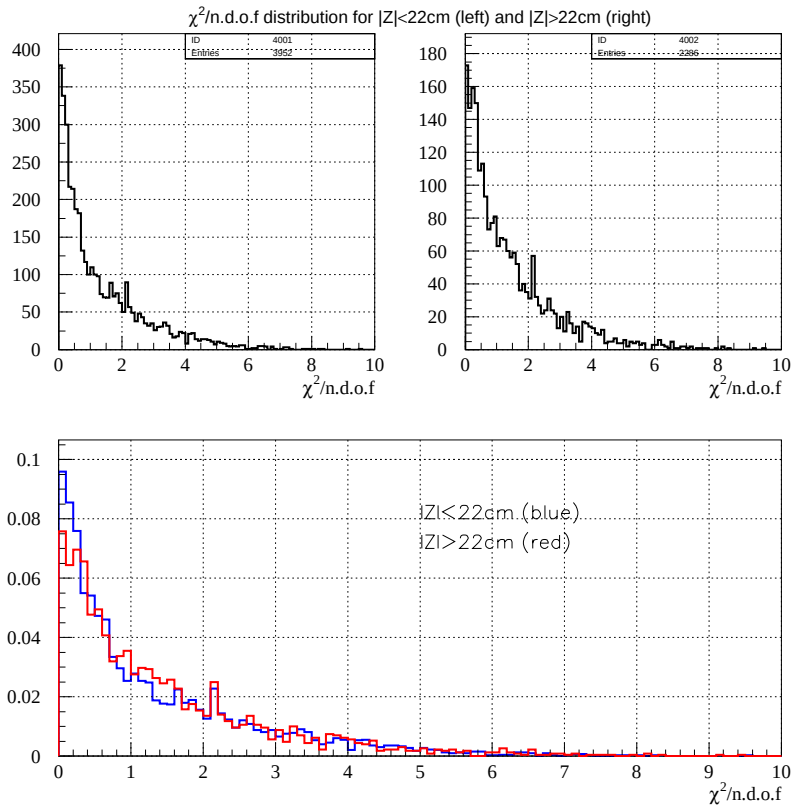


All counters have same distributions.

4. due to UTC fitting effect ?

If UTC z fitting in large dip angle is worse than than in small dip angle...

⇒ Track may actually not pass through T-counter



UTC z fitting quality looks independent on dip angle..

Also, the resolution of UTC z would not be as large as $\sim$ 4 cm..

5. T-counter really has inefficient region ?

If UTC foil 6 has a hit, track should pass through T-counter...

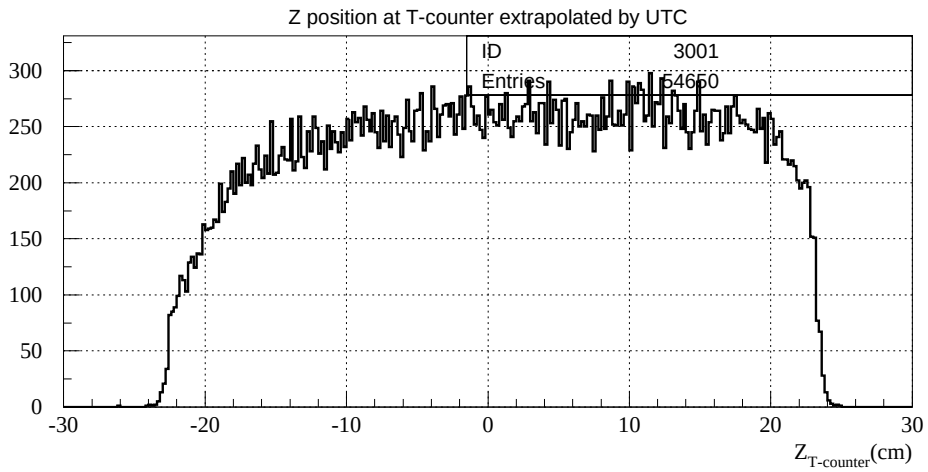
However, the peaks are still there even in this case..

- this happens in all counters,
- UTC z fitting is good even in large dip angle,
- track probably pass through T-counter,

$$\Downarrow$$

It is likely to be less efficiency in the edge of T-counter.

Even with good $T \cdot 2$ hits,

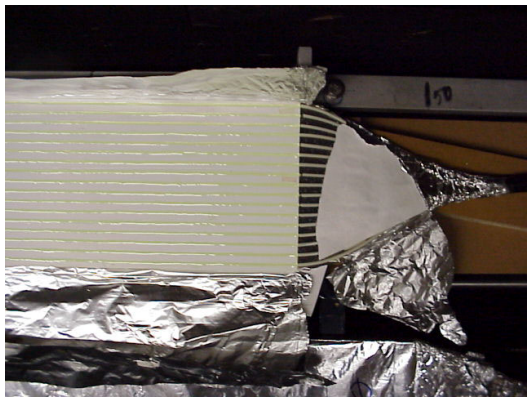


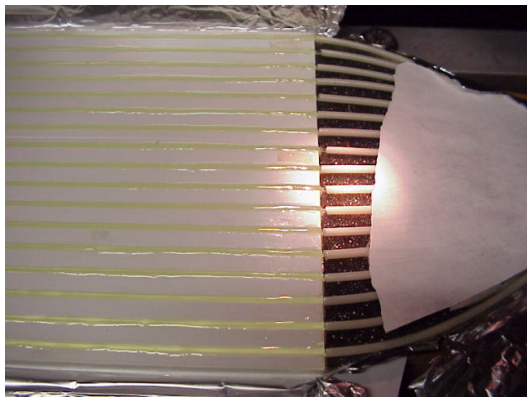
the number of events in the edge is extremely small.

A hypothesis

Inefficiency at the edge may be due to a light leakage

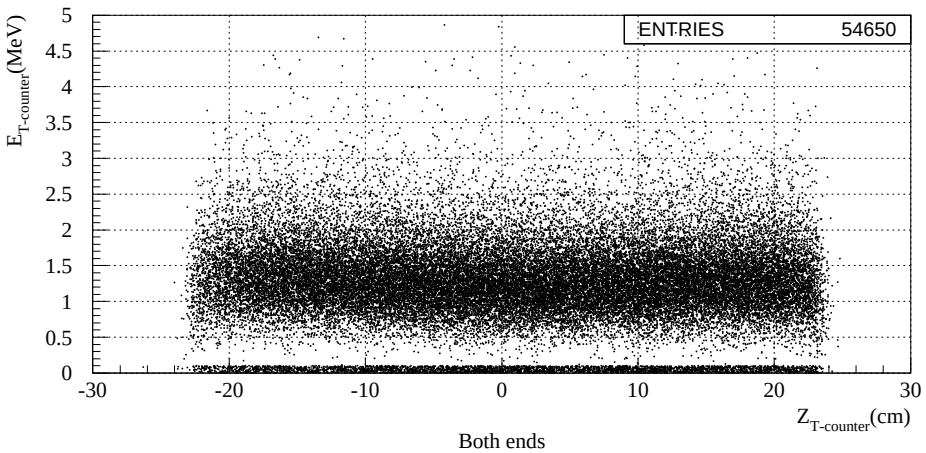
This may happen if T-counter does not have reflector in the end plate.





It can not be seen in these pictures..

Light collection efficiency will be small in the edge.

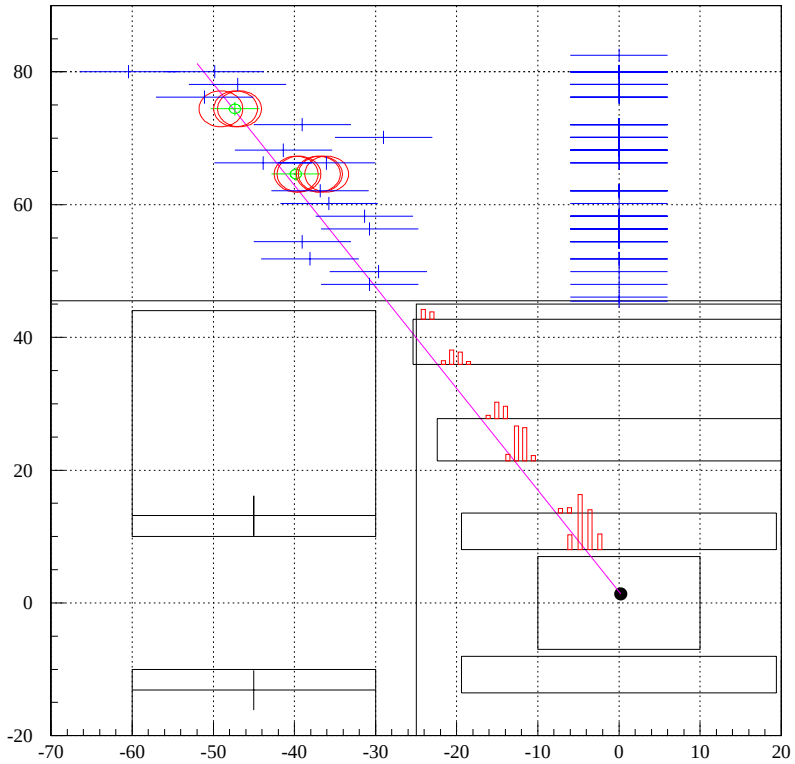


Smaller energy tends to be measured in the edge

However, the edge actually has a reflector...

How do we ensure track really passes through T-counter ?

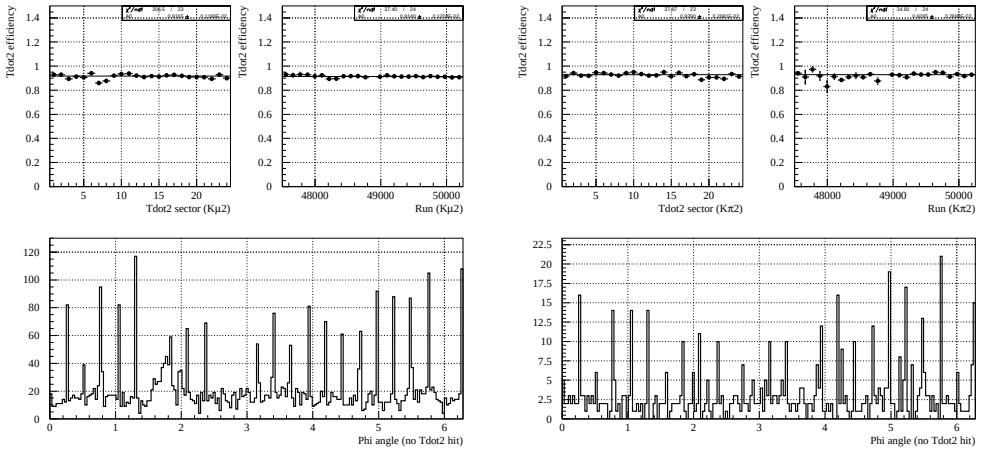
- Requiring $|Z_{T-counter}| < 24$ cm will be bias
- Requiring hits in UTC foil 6 would be better



Setup cut

Cut	$K_{\mu 2}$	$K_{\pi 2}$
ALL	678726	190552
BAD_RUN	678343	190449
BAD_STC	677206	189474
RD_TRK	677206	189474
TRKTIM	677206	189474
UTC/RANGE	677206	189474
UTCQUAL	283160	72785
TARGET	280030	70558
COS3D	269194	68235
B4DEDX	264326	66756
CPITRS	260987	65900
CPITAIL	260766	65844
$\|Z_{IC}\|$ <10cm	248912	60954
TIMCON	247807	60482
DELCO	127739	30518
CKTRS	122638	29520
CKTAIL	114393	27730
BWTRS	109092	26476
U/RPVTRS	106932	25888
TARGF	101866	24642
DTGTTP	101864	24642
RTDIF	100900	24434
TGQUALT	100900	24434
PIGAP	99658	24057
TGB4	93462	22604
KIC	90580	22026
TGGEO	85654	18480
B4EKZ	83870	18101
TGZFOOL	83870	18101
PV(noBV+BVL+RD)	73193	-
FITPI	-	11271
KP2BOX	-	10267
KP2STOP	-	10208
RTOT40	61166	-
UTC foil 6 hit	54227	9147
N$_{K_{\mu 2}}$ or N$_{K_{\pi 2}}$	54227	9147

- ϕ angle distributions



- Inefficiencies

	$K_{\mu 2}$	$K_{\pi 2}$
$\epsilon T \cdot 2 \cdot IC$	0.9134 $\pm$ 0.0012	0.9254 $\pm$ 0.0027
Gap ineff.(%)	3.71	3.65
Counter ineff.(good, %)	4.55	3.81
Counter ineff.(bad, %)	9.52	3.78

- $T \cdot 2 \cdot IC$ efficiency

	This result	values in K-034
$\epsilon T \cdot 2 \cdot IC(K_{\mu 2})$	0.9134 $\pm$ 0.0012	0.8615 $\pm$ 0.0032
$k(K_{\mu 2})$	1.90	1.43
$\epsilon T \cdot 2 \cdot IC(K_{\pi 2})$	0.9254 $\pm$ 0.0027	0.9302 $\pm$ 0.0025
$k(K_{\pi 2})$	1.61	1.72
k	1.76	1.58
$\epsilon T \cdot 2 \cdot IC(\pi^+ \nu \bar{\nu})$	0.9189 $\pm$ 0.0118	0.9018 $\pm$ 0.0334
$\epsilon T \cdot 2 \cdot IC(\pi^+ f)$	0.9189 $\pm$ 0.0118	0.9018 $\pm$ 0.0334

Things To Do

- F_s measurement,

$$F_s = \frac{N_{K_{\mu 2}}}{\epsilon T \cdot 2 \cdot IC(K_{\mu 2}) \cdot (KB_{live})_{K_{\mu 2}} \cdot A_{K_{\mu 2, F_s}} \cdot A^{UMC}_{K_{\mu 2, kin}} \cdot A^{UMC}_{K_{\mu 2, trig}}} \times \frac{1}{0.6351}$$

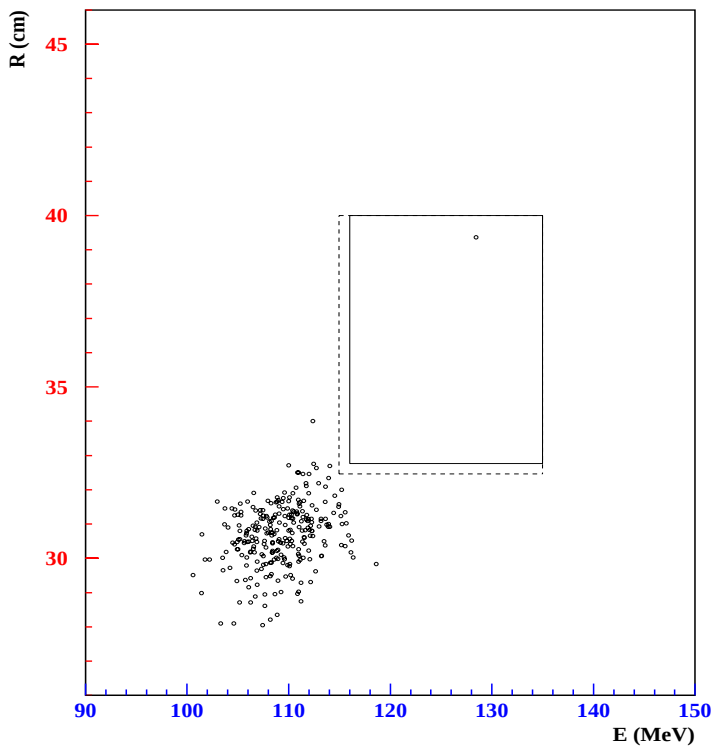
- $K_{\pi 2}$ Branting Ratio Check.

$$BR(K_{\pi 2}) = \frac{N_{K_{\pi 2}}}{\epsilon T \cdot 2 \cdot IC(K_{\pi 2}) \cdot (KB_{live})_{K_{\pi 2}} \cdot A_{K_{\pi 2, Br}} \cdot A^{UMC}_{K_{\pi 2, kin}} \cdot F_s \cdot A^{UMC}_{K_{\pi 2, tri}}}$$

These are under investigation now.

2 Kinematic Background Study in $225 < P_{total} < 229$ Region

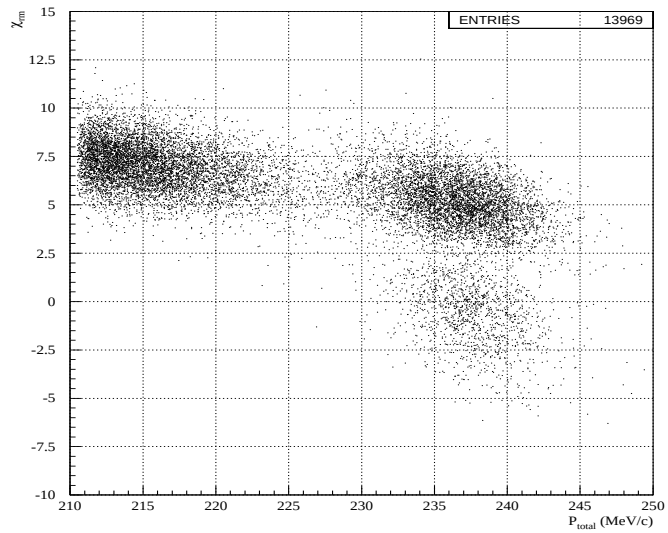
A candidate event was observed near the upper box edge.



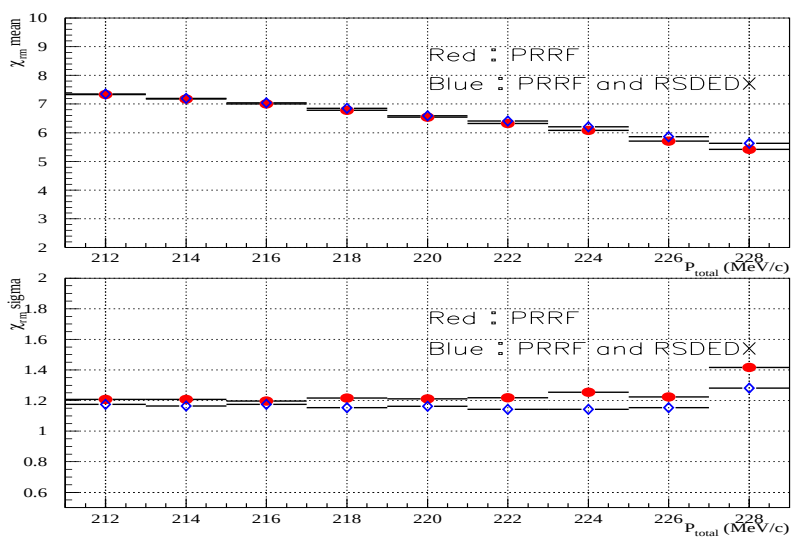
- P_{total} = 227.3 MeV/c
- E_{total} = 128.9 MeV
- R_{total} = 39.2 cm
- χ_{rm} = 0.63

In this region, $K_{\mu 2}$ background is higher.

What does χ_{rm} in this region look like ?



χ_{rm} in band decreases as P_{total} increases



Peak shifts but its sigma doesn't change.

$\Downarrow$

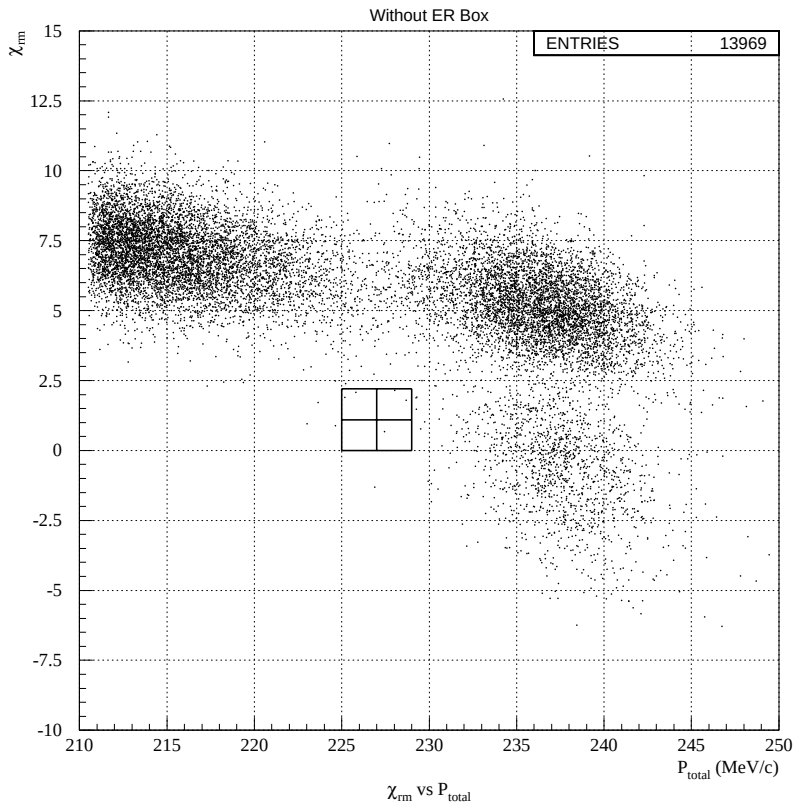
More background may be near the upper BOX edge.

1st step: apply standard bkg function to this region

An assumption

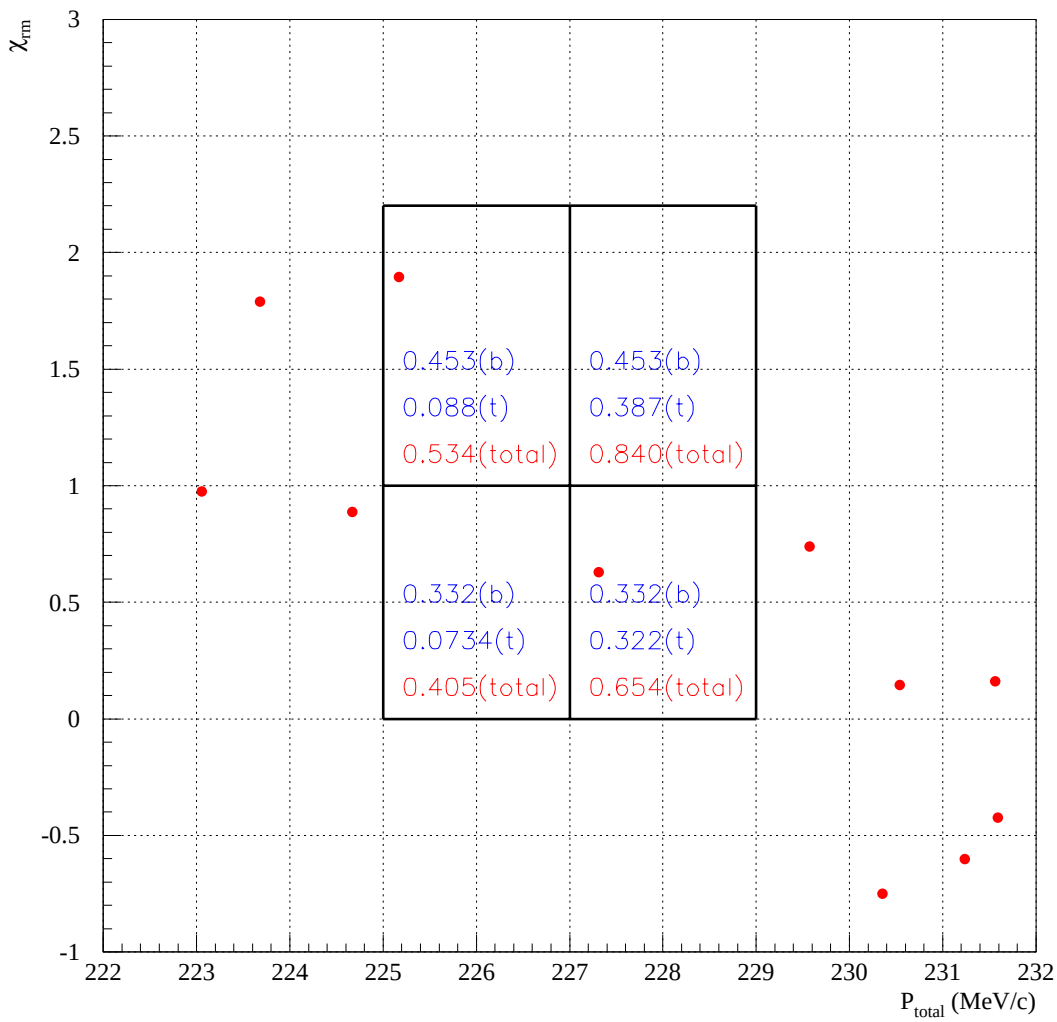
- No P_{total} dependence of χ_{rm}
- No χ_{rm} dependence of P_{total}

Divide the high range region into four



Then estimate the background using bkg function.

Observation and estimation in each cell



The observation is consistent with the estimation.

Normal method is not so bad in this region.

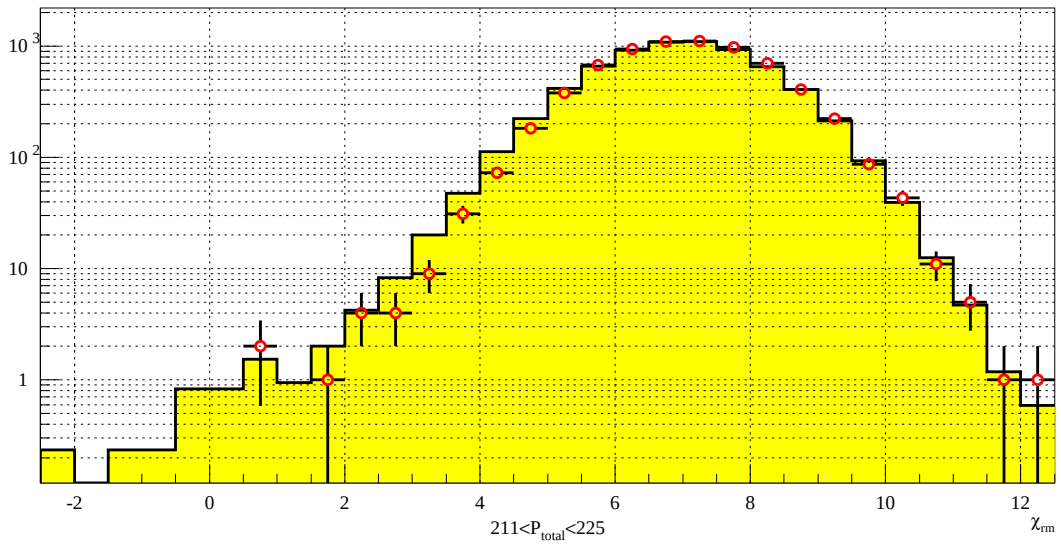
2nd step: Estimate the inpact of $P_{total}(\chi_{rm})$ dependence

How to estimate ?

$\Rightarrow$ P_{total}-dependent bkg function

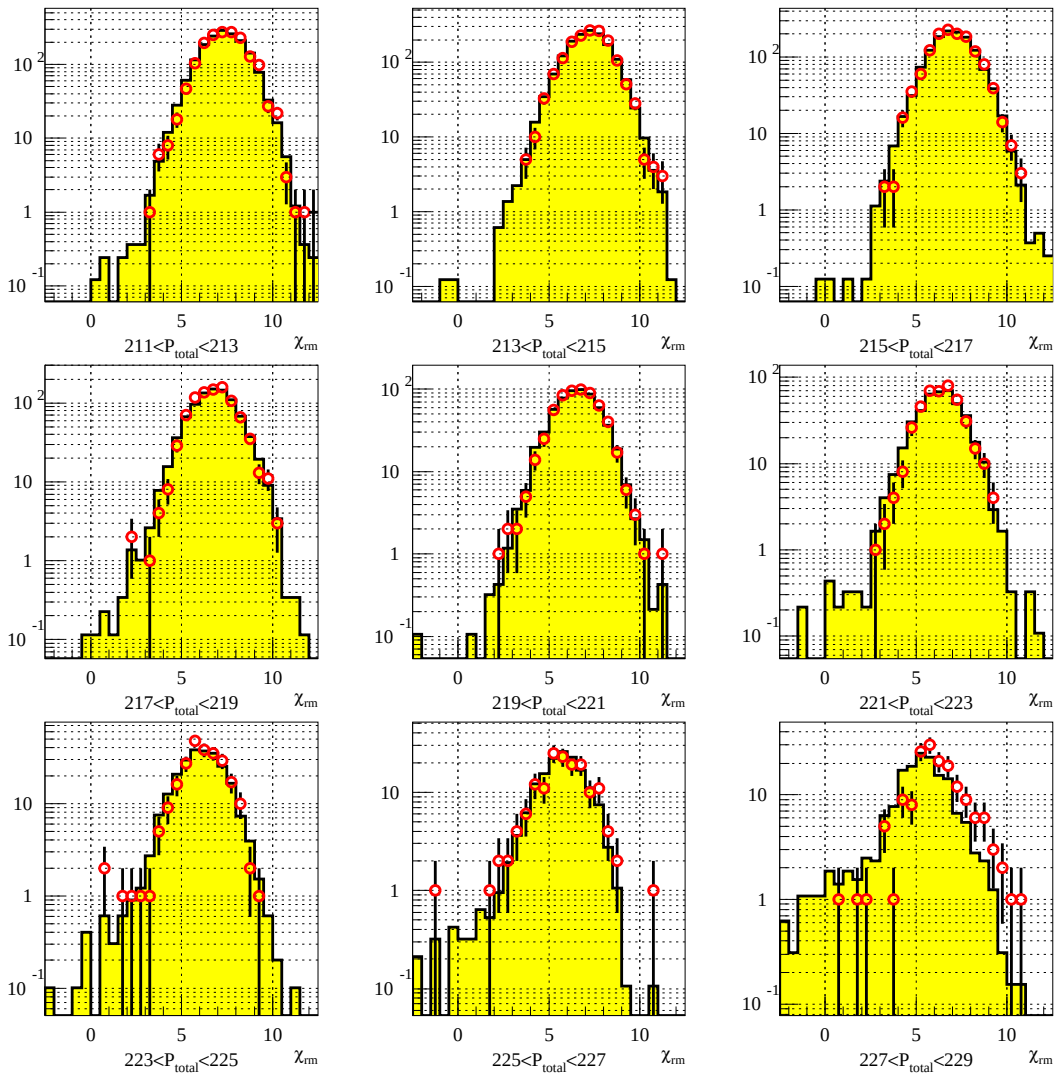
- Consistency between 1st and 2nd bifurcation sample

In $211 < P_{total} < 225$,



Looks consistent.

In each 2 MeV/c bin,



- Both are consistent up to 227 MeV/c
- Difference in $227 < P_{total} < 229 \Leftarrow$ tail contamination

An estimation of the tail contamination is needed.

Things To Do

- Estimation of tail contamination,
- P_{total}-dependent bkg function,
- Reestimate background in $225 < P_{total} < 229$.

3 Summary

$T \cdot 2 \cdot IC$ efficiency study

- $T \cdot 2 \cdot IC$ is measured again,
  Total efficiency, gap and counter inefficiency are consitent between $K_{\mu 2}$ and $K_{\pi 2}$,
- large inefficiency in the edge of T-counter is found,
- final result of $T \cdot 2 \cdot IC$ efficiency is 0.9189 $\pm$ 0.0118 for $\pi^+ \nu \bar{\nu}$ and $\pi^+ f$.

Kinematic Background Study

- Kinematic background near the upper BOX edge is measured,
- P_{total} dependence of χ_{rm} is observed,
- comparison between the observation in the 1st bifurcation and the estimation from the standard 2nd bifurication looks good,
- P_{total}-dependent background function will be prepared,
- reestimation of $K_{\mu 2}$ background will be investigated.