Experiment 949
Technical Note K-xxx

TGdEdX Cut

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Abstract

We observed a 9% acceptance loss in *TGdEdX* compared to what Bipul measured in E787-PNN2. I describe how the cut works, changes made to the cut, and the how I re-calibrated this cut with current data.

1 Description

The dEdx of pions in the PNN2 box 140 MeV/c to 199.5 MeV/c changes from 3.08 MeV/cm to 2.47 MeV/cm in scintillator Therefore the target dEdx cut has to be performed as a function of momentum for PNN2. The *TGdEdX* cut calculates the target dEdX "likelihood" using the total measured momentum (*ptot*) target range (*rtg*), and target energy (*etg*). PISCAT monitors are used to determine the expected *rtg* based upon the observed *ptot, etg*. The data was chosen to be in the pion band. The target range was quantified in 5 momentum bins ($< 170 MeV/c, 170-180, 180-188, 188-199.53, > 199.53$ and 14 target energy bins (0-2MeV, 2-4MeV,..., 26-28MeV); The value of a 15th bin is equal to the 14th bin. For each bin we store the fitted mean and sigma of the measured target range. A Gaussian distribution is assumed during the calibration. Signal events are cut by *TGdEdX* if $like_{tgdedx} < 0.05$.

$$like_{tgdedx} = \frac{1}{2} \cdot (1 + erf\Big(\frac{rtg - rtg_{exp}(etg, ptot)}{\sigma_{exp}(etg, ptot)}\Big)) \quad (1)$$

TGdEdX cuts events when the target range is smaller than expected for a given *etg, ptot*.

2 Changes

In E787-PNN2, *swathccd* does not allow pion hits that occur in kaon flagged fiber; E949 allows this possibility. These K/Pi fibers only exist when $tpi - tk > 15ns$ and so we will not observe these type of hits in Piscat monitors which is used in the calibration. Therefore, we must not include pions hits occurring in a kaon fiber when cutting an event because it is not considered in the calibration sample. *TGdEdX* modifies a local *etg* variable to exclude these hits. All results reported in this note uses this modified version of *TGdEdX*.

3 Calibration

The calibration uses Piscat Monitors. The cuts used to determine the final sample are shown in Table 1. The last cut, $Kpiang > 35°$, was not used in the final determination of the sample due to lack of statistics.

Table 1: Cuts Used in Calibration.

Cut name	Events remaining (Acc)
$BADRUN$	5859925 (-)
$DUPEV$	5859925 (-)
RD_TRK	5859442 (-)
$TRKTIM$	5856748 (-)
$TARGET$	5856748 (-)
$STLAY$	4949979 (-)
UTC	4593392 (-)
$RDUTM$	4497125 (-)
PDC	2833580 (-)
$ICbit$	2833580 (-)
$b4abm2$	1986916 (-)
$tpi - trs$	1881543 (-)
$ictime - trs$	1847951 (-)
BAD_STC	**1845076** (-)
$TGCUT$	1508139 (0.817386)
$tgqualt$	1435572 (0.951883)
$npitg$	1435572 (1)
$timcon$	1430524 (0.996484)
$tgtcon$	1390018 (0.971685)
$b4etcon$	1360826 (0.978999)
$targf$	1278186 (0.939272)
$dtgttp$	1278117 (0.999946)
$rtdif$	1181683 (0.92455)
$eiccon$	1149627 (0.972873)
$ticcon$	1149616 (0.99999)
$pigap$	1034138 (0.899551)
$tgdb4$	886404 (0.857143)
$tgdb4tip$	561715 (0.633701)
$tgdvxtip$	466019 (0.829636)
$tgdvxpi$	427166 (0.916628)
TGB4	427166 (1)
$phivtx1$	315481 (0.738544)
$pv(not\ tg)\ Loose60$	87063 (0.275969)
$cos3d$	76823 (0.882384)
$utcqual\ Loose$	72564 (0.944561)
$rngmom$	65767 (0.906331)
$rsdedxmax$	46384 (0.705278)
$rsdedxcl$	41896 (0.903242)
$rslike$	41429 (0.988853)
RSDEDX	41429 (1)
$tgz > -10.$	41244 (0.995535)
$Kpiang > 35$	**23662** (0.573708)

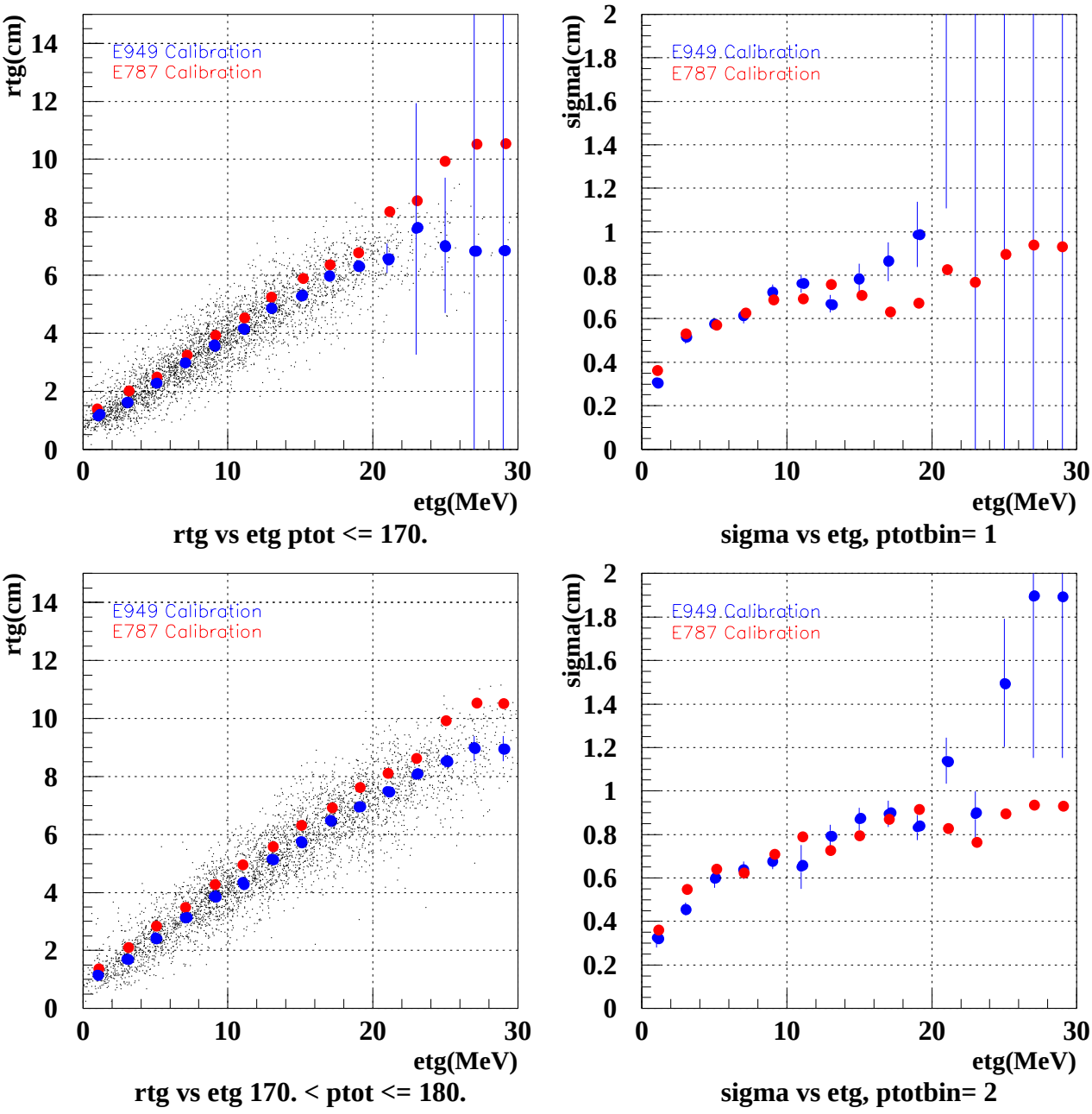

Figure 1: Calibration of new means. Red points are the original means. Blue points are the new means with error bars being the uncertainty on the mean from a gaussian fit

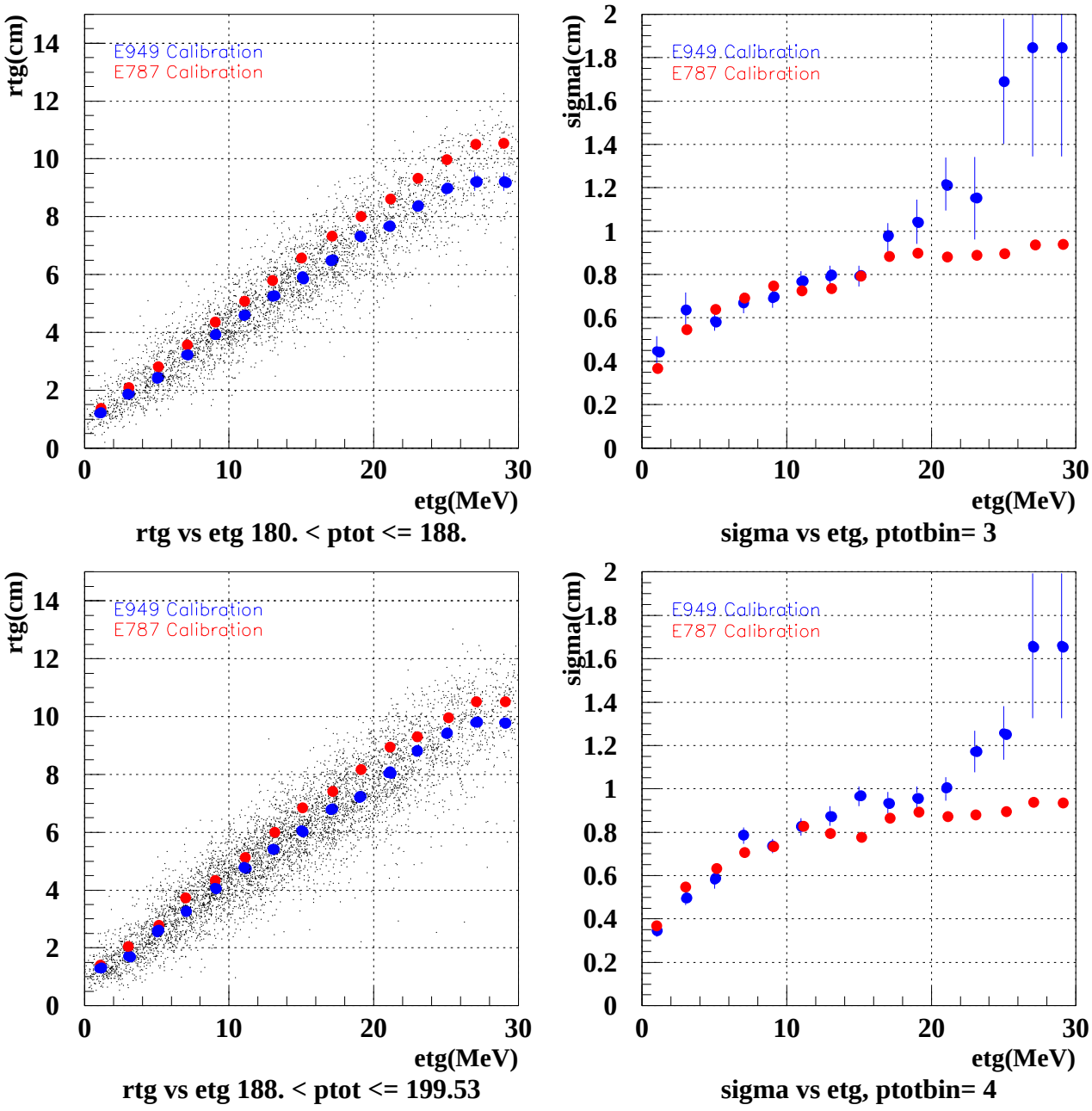

Figure 2: Calibration of new means. Red points are the original means. Blue points are the new means with error bars being the uncertainty on the mean from a gaussian fit

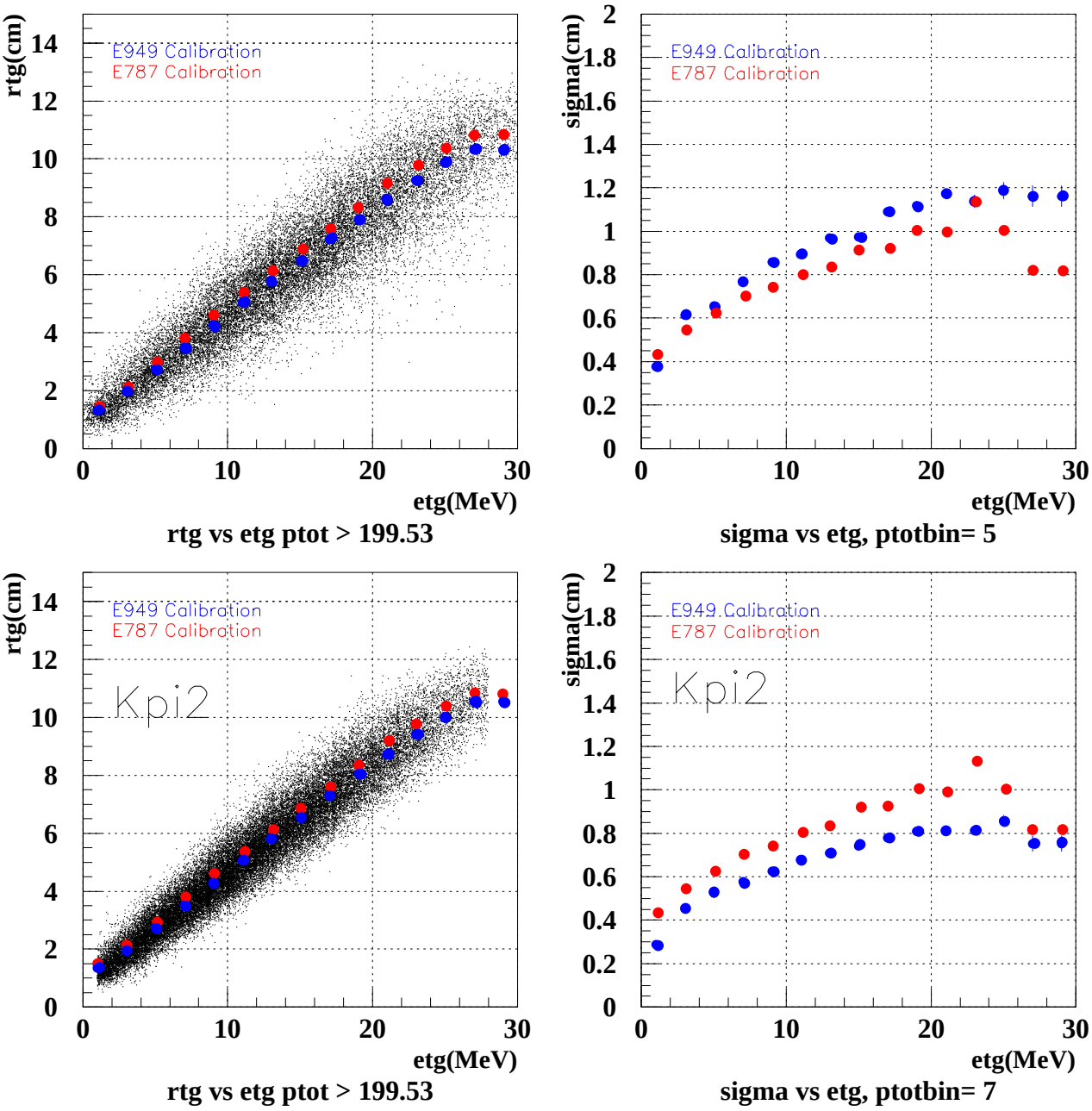

Figure 3: Calibration of new means. The bottom plot is doing the calibration process on Kpi2 montiors. Red points are the original means. Blue points are the new means with error bars being the uncertainty on the mean from a gaussian fit

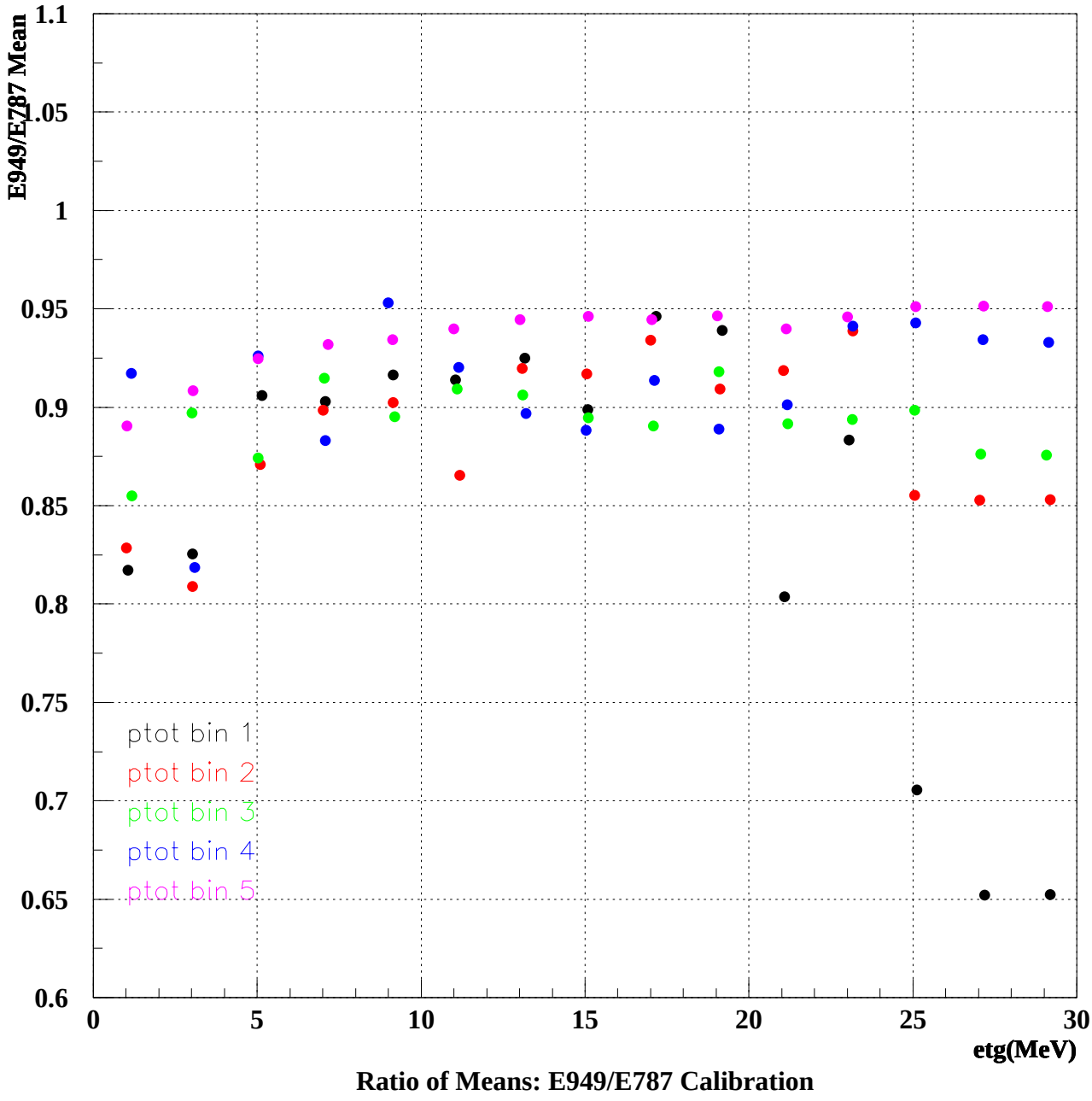

Figure 4: Ratios of the E949/E787 Calibrations.

3.1 Original Parameters

The means and sigmas are listed below in the 5 *ptot* bins, meanN such that $N = 1 : \ ptot < 170MeV/c$, $N = 2 : \ 170 < ptot \leq 180$, $N = 3 : \ 180 < ptot \leq 188$, $N = 4 : \ 188 < ptot \leq 199.53$, $N = 5 : \ ptot > 199.53$; Same notation for sigmas. The 15 numbers in each row are for $etg = 1MeV, \ 3MeV, ..., \ 29MeV$.

data mean1/1.41,1.99,2.51,3.28,3.92,4.56,5.23,5.88,6.30,6.77,8.2,8.6,9.95,10.5,10.5/
data sigm1/0.36,0.53,0.57,0.62,0.69,0.70,0.76,0.71,0.64,0.67,0.83,0.77,0.90,0.93,0.93/
data mean2/1.41,2.09,2.82,3.50,4.29,5.02,5.62,6.31,6.96,7.60,8.17,8.58,9.95,10.5,10.5/
data sigm2/0.36,0.54,0.64,0.62,0.71,0.79,0.72,0.79,0.88,0.91,0.83,0.77,0.90,0.93,0.93/
data mean3/1.41,2.09,2.82,3.53,4.36,5.05,5.83,6.60,7.29,7.99,8.61,9.33,9.95,10.5,10.5/
data sigm3/0.36,0.54,0.64,0.70,0.74,0.72,0.73,0.79,0.89,0.90,0.87,0.89,0.90,0.93,0.93/
data mean4/1.41,2.09,2.82,3.72,4.28,5.17,6.06,6.83,7.39,8.17,8.93,9.33,9.95,10.5,10.5/
data sigm4/0.36,0.54,0.64,0.71,0.73,0.83,0.79,0.78,0.86,0.90,0.87,0.89,0.90,0.93,0.93/
data mean5/1.48,2.15,2.97,3.75,4.58,5.37,6.10,6.84,7.64,8.36,9.16,9.77,10.38,10.83,10.83/
data sigm5/0.44,0.54,0.62,0.71,0.74,0.80,0.84,0.91,0.92,1.0,0.99,1.14,1.0,0.81,0.81/

3.2 New Parameters

data mean1/1.15,1.64,2.27,2.96,3.59,4.16,4.83,5.29,5.95,6.35,6.58,7.,7.5,8.0,8.0/
data sigm1/0.31,0.52,0.57,0.61,0.72,0.76,0.67,0.79,0.86,0.99,1.04,1.28,1.28,1.28,1.28/
data mean2/1.17,1.69,2.45,3.15,3.86,4.35,5.17,5.77,6.49,6.91,7.50,8.05,8.53,8.96,8.96/
data sigm2/0.33,0.46,0.60,0.64,0.68,0.65,0.79,0.87,0.90,0.83,1.14,0.89,1.50,1.89,1.89/
data mean3/1.20,1.87,2.46,3.23,3.91,4.59,5.29,5.91,6.50,7.34,7.67,8.35,8.95,9.21,9.21/
data sigm3/0.45,0.64,0.59,0.67,0.69,0.77,0.79,0.79,0.97,1.04,1.22,1.15,1.69,1.85,1.85/
data mean4/1.29,1.71,2.61,3.29,4.08,4.77,5.43,6.07,6.76,7.27,8.04,8.78,9.40,9.80,9.80/
data sigm4/0.35,0.49,0.58,0.78,0.74,0.82,0.87,0.97,0.94,0.96,1.00,1.17,1.26,1.66,1.66/
data mean5/1.32,1.96,2.74,3.50,4.27,5.04,5.76,6.47,7.21,7.91,8.59,9.25,9.88,10.30,10.30/
data sigm5/0.38,0.61,0.66,0.77,0.86,0.89,0.97,0.97,1.09,1.12,1.17,1.14,1.19,1.16,1.16/

3.3 Manual changes

The fit in the *ptot* range of $< 170MeV/c$ and $etg > 20MeV$ was very poor due to lack of statistics. I modified the last 5 values. The means were determine by constraining the values below the values observed in mean2(11-15) and doing a linear extrapolation from the previous set of points. This was done by "eye". The last 4 sigmas were determine by doing a fit on rtg values with a slice of $20 < etg < 30$ and performing a gaussian fit. I determined the sigma for the $etg = 19MeV$ by extending the etg-slice to $17 < etg < 21$.

- From fits

  data mean1/1.15,1.64,2.27,2.96,3.59,4.16,4.83,5.29,5.95,6.35,6.58,7.60,7.03,6.84,6.84/

  data sigm1/0.31,0.52,0.57,0.61,0.72,0.76,0.67,0.79,0.86,0.99,2.02,3.64,3.84,12.70,12.70/

- By hand

  data mean1/1.15,1.64,2.27,2.96,3.59,4.16,4.83,5.29,5.95,6.35,6.58,7.,7.5,8.0,8.0/

  data sigm1/0.31,0.52,0.57,0.61,0.72,0.76,0.67,0.79,0.86,0.99,1.04,1.28,1.28,1.28,1.28/

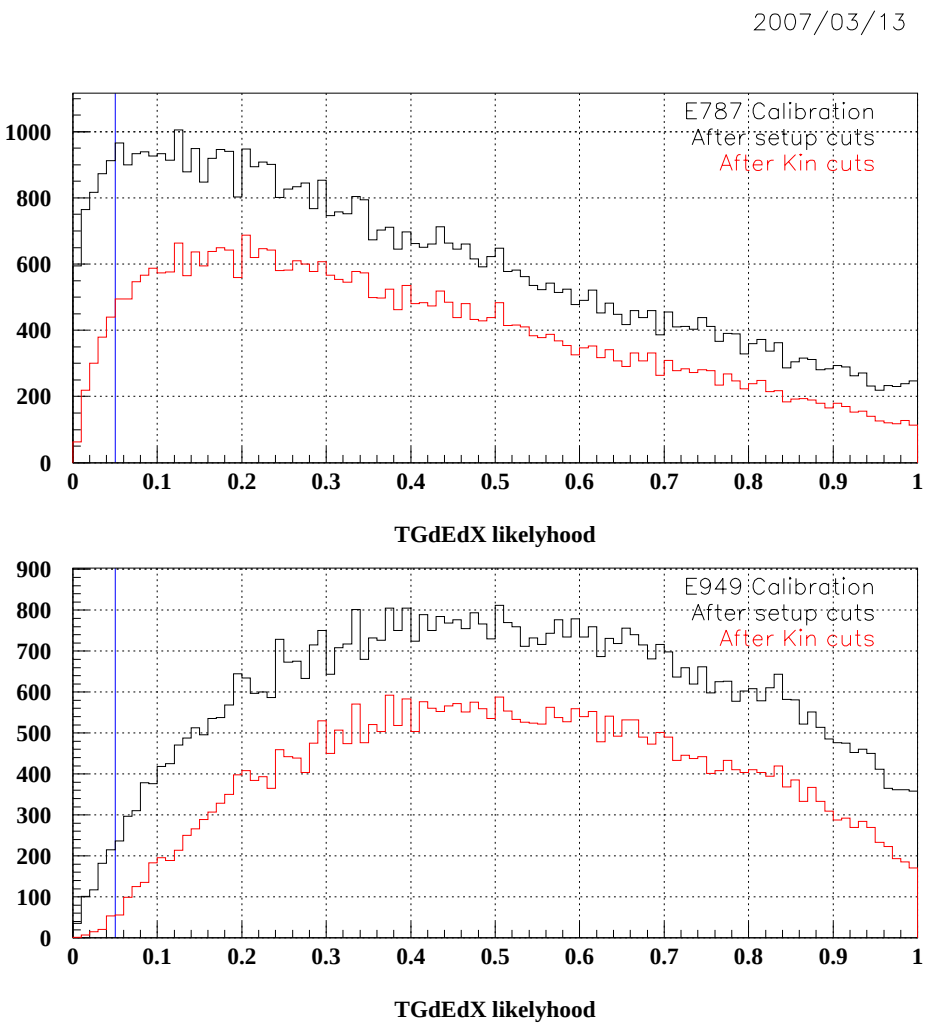

Figure 5: Before and after calibration of $like_{TGdEdX}$. The plots are done in the Kpi2-TG Kinematic acceptance study. The setup cuts are all cuts applied before $TGdEdX$ cut is applied. The Kin cuts are all cuts in the acceptance study except for $TGdEdX$. $TGdEdX$ cuts events less than 0.05, shown as the blue line.

The calibration is done on Piscats and the acceptance measurement is done on Kpi2 monitors. As observed in Figure 5, the E949 calibration creates a $like_{TGdEdX}$ distribution, with Kpi2 monitors, that has a mean of 0.25 and a sigma of 0.777 (gaussian fit). This implies that our calibration sample has worse resolution that our acceptance sample.

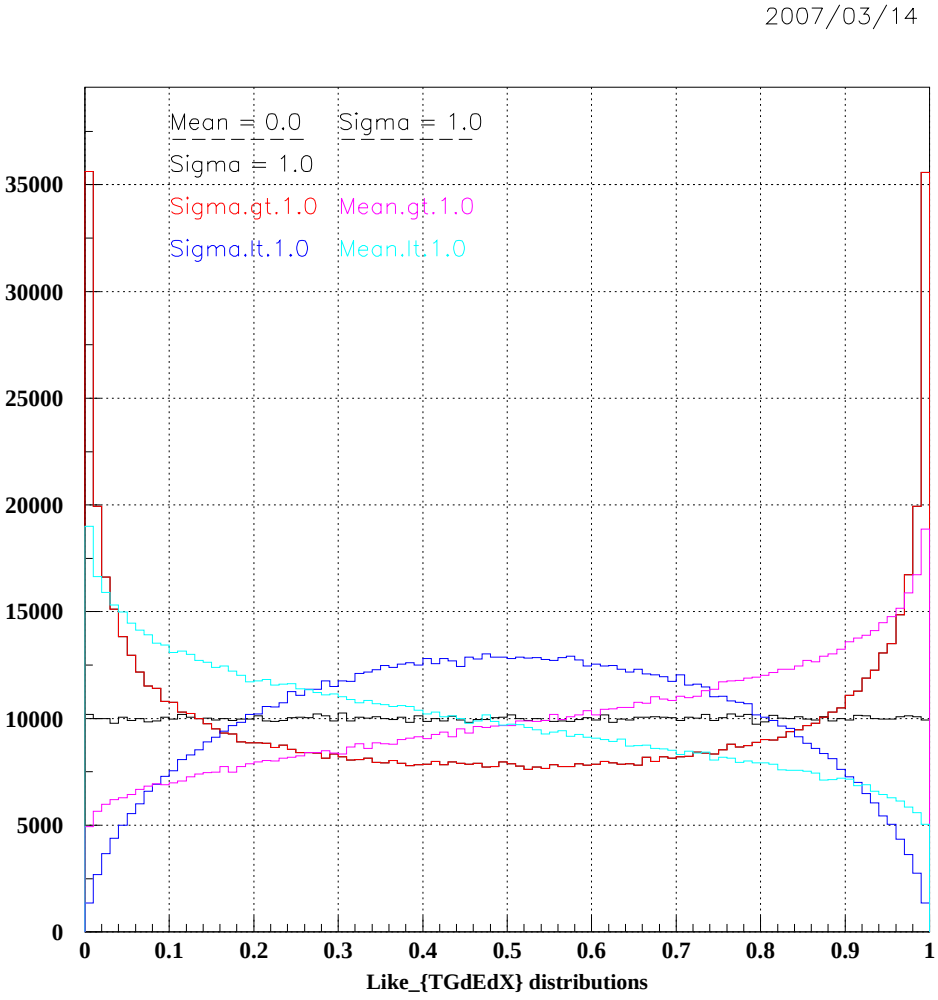

Figure 6: $like_{TGdEdX}$ distributions for different offsets in the calibration.

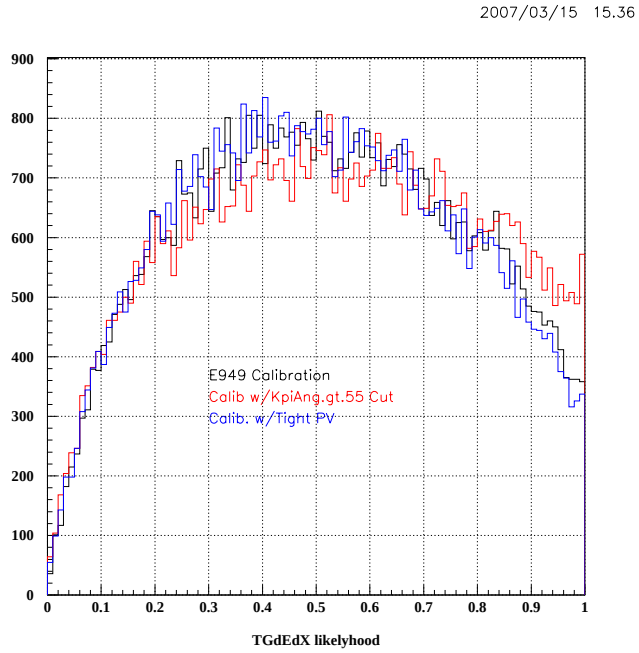

Figure 7: $like_{TGdEdX}$ distributions for different piscat calibrations.

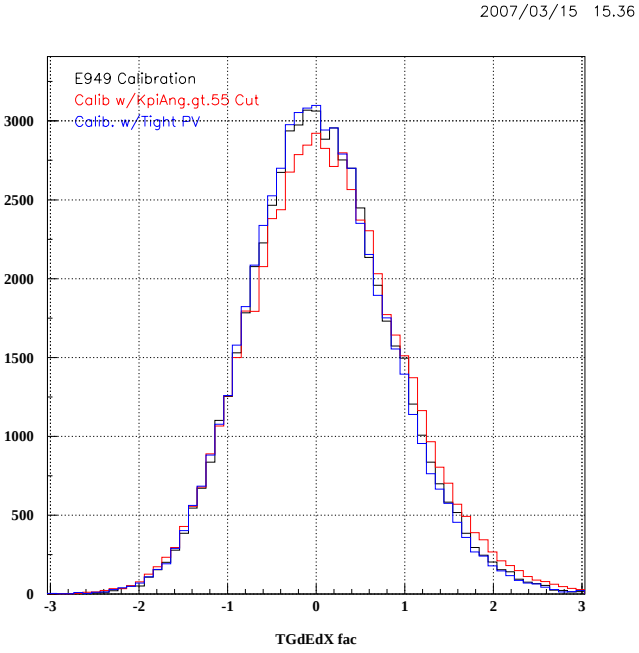

Figure 8: $\frac{rtg-rtg_{exp}(etg,ptot)}{\sigma_{exp}(etg,ptot)}$ distributions for different piscat calibrations.

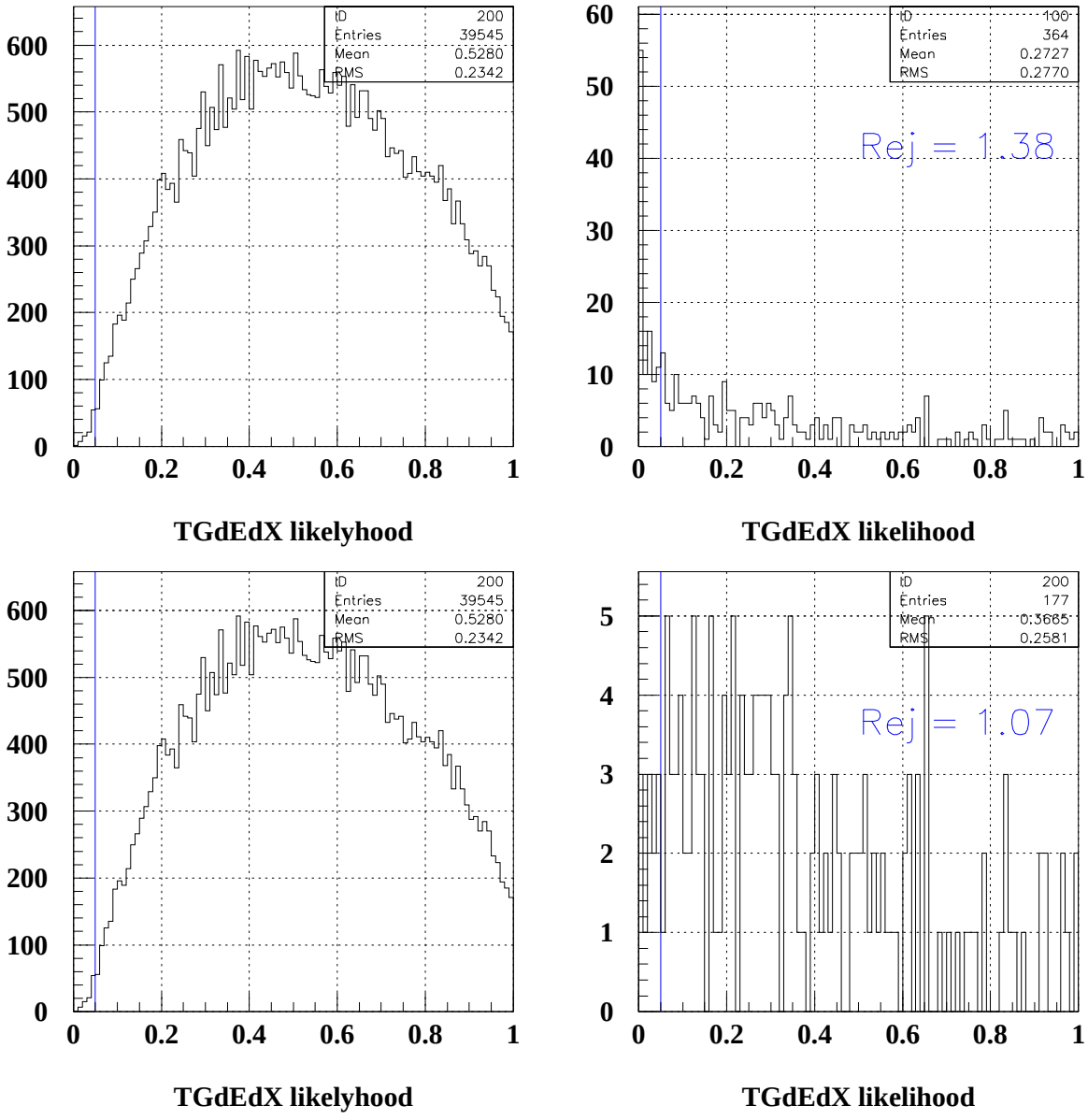

Figure 9: Bipul had a rejection of 1.44. No rejection after all cuts.

4 Acceptance and Rejection

E787-PNN2 measured an acceptance of 0.9858. Using the E787-PNN2 calibration, I measure an acceptance of 0.9339. With the new parameters the acceptance of *TGdEdX* increases to 0.989; An increase of 5.2%. The overall acceptance increase in the Kpi2 TG-Kinematic study is 2.0%. The correlation of *epitg* and *chi567* mitigates the increase observed in *TGdEdX*.

E787 tuned the cut to a $Rej_{TGdEdX} = 1.44$, but *TGdEdX* had no rejection after all cuts. This is due to high correlation with *chi567*.

cut value	*Acc*	*Rej*	$Acc \times Rej$
E787 0.05	0.9858	1.44	1.42
E949 0.05	0.989		

Table 2: *TGdEdX* Acceptance Rejection Table. The *TGdEdX* cut is $like_{TGdEdX} < cut\ value$.

5 Results