E-949 TN-xxx
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Experiment 949
Technical Note No. xxx

PNN2 Beam Background

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Abstract

This note details the work done to determine the beam background estimate for PNN2.

1 Introduction

The beam background analysis detailed in this technote used comis analysis that PNN1 standardized. The first step was to reproduce the results from PNN1 by using the same procedure as done in k034 section 5. We were not able to reproduce the exact number shown in k034/k038 due to changes in the pass2 source code. However, the reproduced background numbers were close enough to the k034 1/3 reported numbers to give us confidence that the current scripts and cuts were being implemented correctly.

The working directories of the beam background is located on the TRIUMF cluster in the directory `~benjil/bmbkg/`.

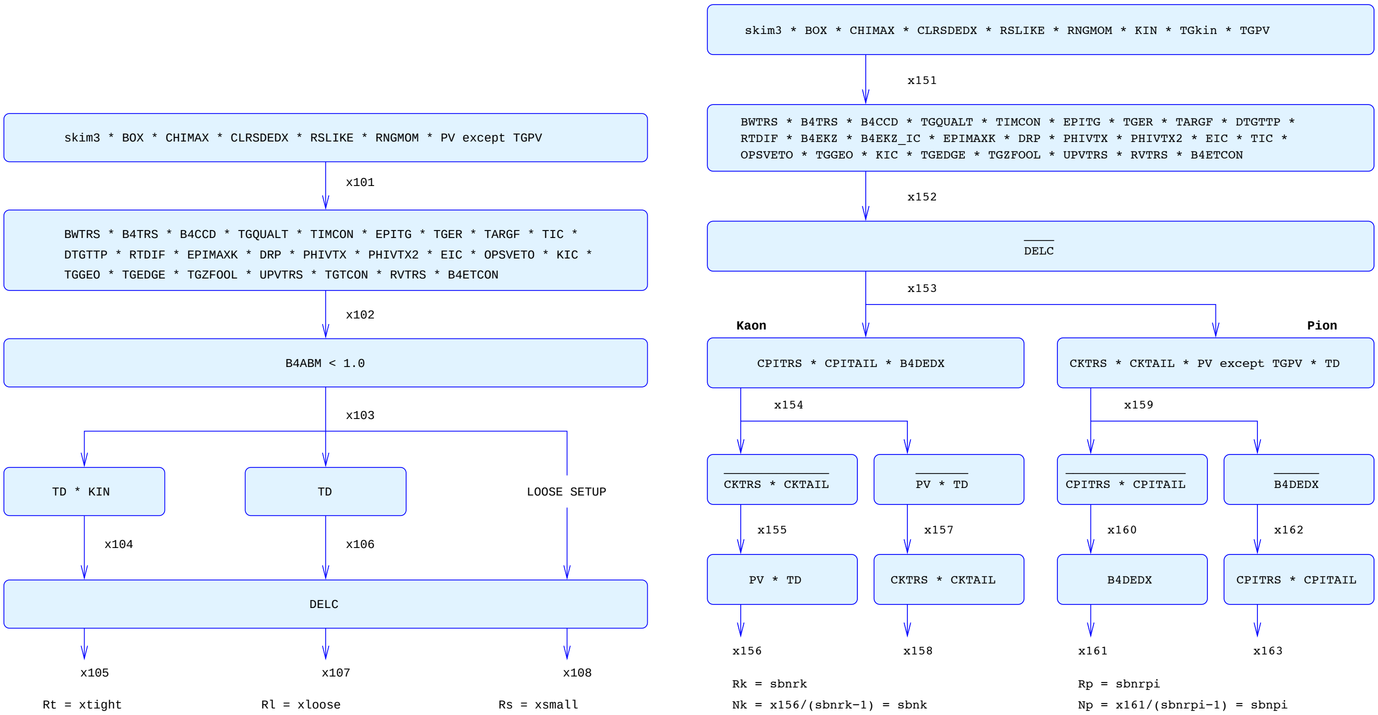
Directory/Files	Description
./README	File describing files and how to produce results.
./src/	Source code and scripts
./backups/	Tar-ed backup of source code at various points during development.
./skim/	Output of analysis. Categorized by date.
./studies/	Additional information for specific studies.

Table 1: Beam Background Directories

1.1 Background Estimate

We assume there is at least one event remaining in all branches of the bifurcation studies, i.e. In the case of zero events remaining we change this to one. In the beam background we have applied a PV cut with acceptance of 95% instead of the final Photon Veto cut for this analysis. Currently we expect this final acceptance of the PV cuts to be 60%. This factor of .60/.95 = 0.63 will be accounted for when determining the final 2-beam background value.

Due to the lack of statistics, we have not applied the $K_{\pi2}$ *target scatter*cuts. This list of cuts include the following: *chi567,verrng, chi5max, angli, ALLKfit, tpics, epionk, ccdpul, timkf*. Not applying these cuts to the normalization branches will make the background estimate higher than the true value. We will apply a correct for not applying these cuts. The acceptance factor from E787-PNN2 of these cuts is 0.283.



(a) Rejection (b) Normalization

Figure 1: 1-Beam Bifurcations

2 1-Beam Background

The 1-beam background was measured to be much smaller than the 2-beam background. Therefore, most of the work to date was concentrated on determining and lowering the 2-beam background.

The 1-beam rejection sample is tagged, as seen in Figure 1, by looking for a π-like hit at beam-time. This is done by the $b4abm\_atc < 1.0MeV$ requirement. The rejection sample then bifurcates. Ideally we would determine the rejection of $DELCO$ by applying the tightest constrains, $TD \cdot KIN$. However, we may loosen the cuts to improve statistics.

As pictured in Figure 1, the 1-beam normalization sample is tagged by inverting the $DELCO$ cut and applying all other cuts. In the PNN2 analysis, we also have the additional cuts from the $K_{\pi 2}$ *target scatter*.

rejection (n)	PNN2(1/3)
Loose Setup	9517.0 ± 5494.4 (3)
TD	8655.5 ± 6120.0 (2)
$TD \cdot KIN$	5866.0 ± 5865.5 (1)

Table 2: **1-Beam Rejection Summary**. Each row is a different branch to measure the DELCO rejection. First number is the rejection. The number is parenthesis is the number of events remaining that the rejection is based upon. The minimum rejection is used in calculation of the 1-BM background for a conservative estimate.

Norm. branches	PNN2(1/3)
ALL cuts below NORM	1.0 ± 1.0
$PV \cdot TD$ *norm*	8.0 ± 2.8
$CkTRS \cdot CkTail$ *rej*	4.2 ± 0.7
$B4DEDX$ *norm*	1.0 ± 1.0
$CpiTRS \cdot CpiTail$ *rej*	0.0 ± 0.0
N_K	2.5 ± 1.0
N_{pi}	99999.0 ± 12499.9

Table 3: **1-Beam Normalization Summary** The ALL-cuts-below row uses the combination of all cuts in the following 4 rows (branches) and is the normalization number used in the calculation of the numbers reported in Table 10 (Total Background). The sum of the last two rows provide a check on the ALL-cuts-below number.

3 2-Beam Background

It was discovered that we have an obstacle to contend with during the measurement of the 2-beam background. The obstacle was due to a PNN2 trigger definition changed, during the run. This was documented on page 28 of k025:

- 04/29/02 19:26 49151 new pnn2 trigger pnn2_new = pnn2.and.(pnn2_ps16 +$\overline{C_\pi}$).

  The pnn2 trigger is
  $KB \cdot IC \cdot DC \cdot T \bullet 2 \cdot 3_{ct} \cdot 4_{ct} \cdot 5_{ct} \cdot 6_{ct} \cdot (\overline{13_{ct} + \cdots + 18_{ct}}) \cdot (\overline{19}) \cdot \overline{BV + BVL + EC} \cdot L0rr2(1) \cdot HEX \cdot L1.n$

The new trigger becomes $pnn2\_trigger \cdot (ps16 + \overline{C_\pi})$. The prescale-16 was done on the trigger board directly. A problem arises because we did not send the ps16 bit to the DAQ system. So we do not know if the trigger was from the ps16 bit or not.

This only affects the 2-beam Kaon-π background??

The trigger change required us to break the data into two sets, before and after the trigger change. With the first half, we are able to proceed with the standard method done in PNN1. When we analyzed the second half, we found that the statistics was very low and the background for the 2-beam Kaon-Pion (Kpi) was very large with large uncertainty (). At this point, during the beam-background study the N_{beam} was on the same order as we were expecting from the $K_{\pi 2}$ target scattering.

The analyze the 2-beam background we will first determine and understand the first half of the data. We expect that we will be able to scale the PNN1 beam background for the second half based upon the information we determine in the first half. This will remove our problem with the statistics.

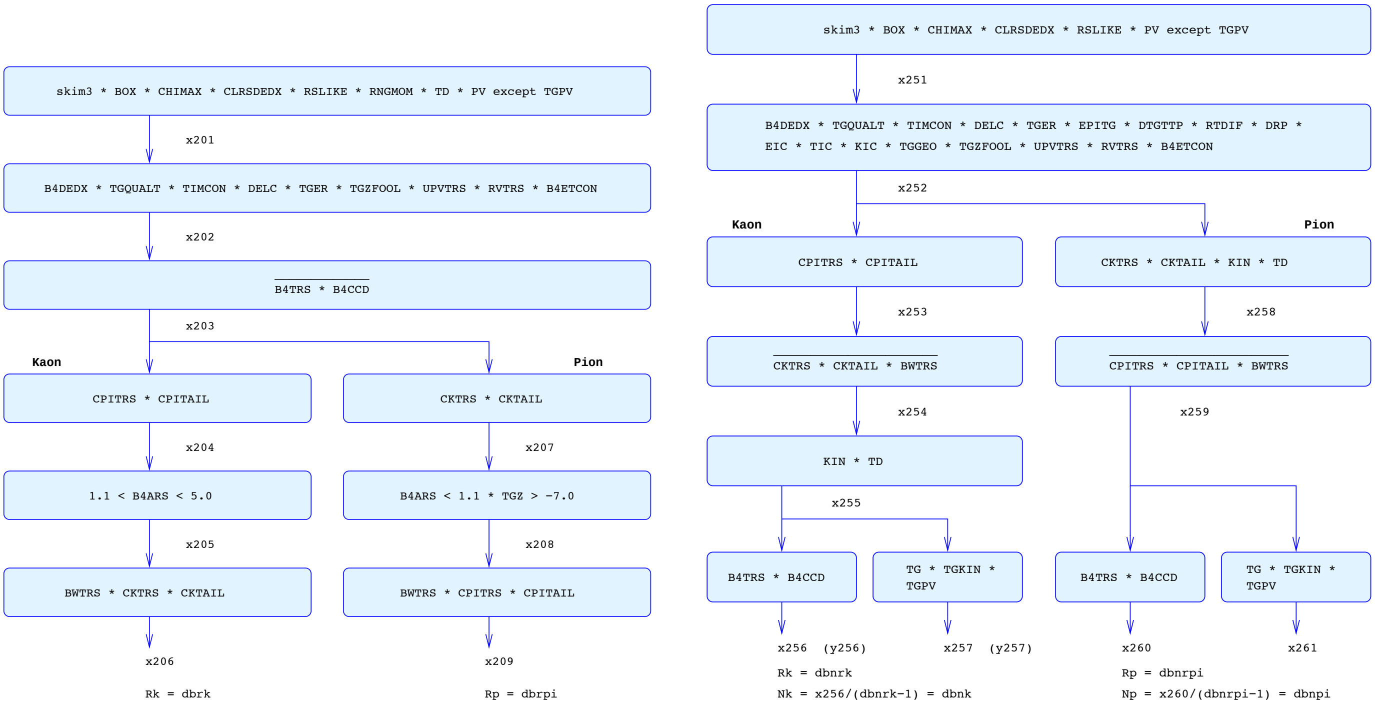
As in the previous PNN2 analysis the Kaon-Kaon background dominates and so much of the work started with trying to understand and reduce this background before proceeding to the Kaon-π background.

3.1 Kaon-Kaon (KK)

To measure the rejection of the 2-beam cuts we first assume that the Beam-Wire Chambers (BW) and the Cerenkov Detectors to be uncorrelated to the B4 detector. This assumption is valid because these detectors are suffectly separated in space and the beam particles will most likely scatter in the Inactive and Active Degraders (ID/AD). So to measure the rejection of the BW and CK cut we must first obtain a sample of 2-beam events, events that have two particles originating from upstream of the detector.

As seen in Figure 2, the PNN1 KK rejection sample is tagged by applying $\overline{B4TRS \cdot B4CCD}$. This equates to having a hit in the B4 detector at Range Stack time (trs time), so we get a 2-beam sample. We obtain a KK sample by cutting away hits that appear to be pions by applying $CPITRS \cdot CPITAIL$. We then require that the hit in B4 at trs-time be kaon-like by requiring the B4 energy at trs-time (*b4ars_atc*) be between 1.1 and 5.0 MeV. At the point x205 in Figure 2 we have what we believe is a pure sample of 2-beam KK events, so we are now able to measure the rejection of $BWTRS \cdot CKTRS \cdot CKTAIL$.

In E787-PNN2, Milind and Bipul observed contamination of the 2-beam rejection sample. The contamination was from Kaon decay from multiple charged particles like $K^+ \rightarrow \pi^+\pi^-e^+\nu$ or the $K_{\pi 2} - scatter$ events with a Daltiz decay of $\pi^0 \rightarrow \gamma e^+e^-$ or conversion of photons in the target. Basically something becomes a contamination of the sample when we have something that can produce a



(a) Rejection (b) Normalization

Figure 2: 2-Beam Bifurcations (Kaon-Kaon and Kaon-Pion)

B4 hit at decay time. We remove this contamination by adding the criteria that the tag also includes inverting the TARGF cut. So $(\overline{B4TRS \cdot B4CCD})$ becomes $(\overline{B4TRS \cdot B4CCD}\ AND\ \overline{TARGF})$. TARGF is the minimum distance from any kaon fiber to any pion fiber in the Target (from fiber center to fiber center). This essentially removes any events that have a decay product emerging from the Kaon identified by *swathccd* . We make an assumption here that the 2-beam background is the same whether the two particles come close geometrically in the target or are separated.

After applying the PNN2 tagging scheme to the PNN1 2-beam rejection structure, we see that 58 events survive all the rejection cuts. The sample analyzed was PNN1+PNN2 triggers up to the PNN2 trigger change, so less than half of the available 1/3 data. The rejection was measured to be very low, $30. \pm 4.$. So a visual scan of these 58 remaining events was performed to determine what if any contamination we have.

After scanning most of the 58 events it was evident that around a half of the events were due to target scatters, which is PNN2's largest background. As seen in Figure 3, *swathccd* was unable to correctly reconstruct this event. However, visually we are able to easily discern that the photon-veto fibers adjacent to the kaon fibers are in fact pion fibers before the scatter occurred in the 18.2 MeV fiber. These scatter events were tagged because the products from the decay caused hits in the B4 detector, i.e. not from a second beam particle. This discovery led to the creation of a modified version of $\overline{TARGF}$.

3.1.1 *kpi_gap* cut

The signatures of a TG-scattering event that is reconstructed (incorrectly) by *swathccd* are photon-veto fibers adjacent to the decay vertex and the photon-veto fibers being between the pion fibers

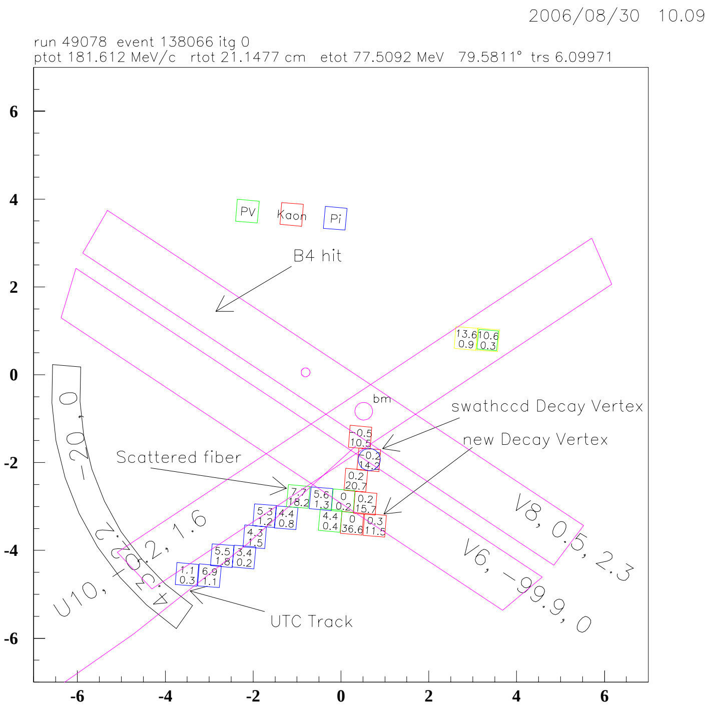


Figure 3: Example of a Scatter event that will be removed by *kpi_gap* . Red = Kaon, Blue = Pions, Green = PV. The pink curve is the UTC extrapolation. The pink blocks are B4 hits.

and the decay vertex. A better and complete method would be to incorporate the *TGrecon* and *KinkFinder* . However, this solution requires reprocessing of the data at the PASS2 level and a lot of coding. A very basic and quick solution was formed by creating a comis function that was named *kpi_gap.function* and placed in the `$PASS2_ANAL/func/` area.

kpi_gap has the following coding steps.

- $\overline{TARGF}$

- Search for PV-fibers that are within ±3ns of trs and adjacent to a kaon fiber (within 0.7cm center to center). Let's call these PV' fibers.

- Determine the best decay vertex with the given information.

  Modified *decay_vertex.function* to determine the decay vertex based upon B4 information (if available). If B4 information is not available, then default to *swathccd* 's determination (tgx,tgy). An example of the determination of a new Decay Vertex is shown in Figure 3.

- Determine if one of the PV' fibers are within a box. The determined decay vertex is one corner and the nearest pion is the other corner. This step forces the photon veto fiber to be between the pions and the decay vertex. This also helps when the decay-vertex finder isn't able to determine the best fiber, i.e. gets close but not exact.

- Because the previous step's "box" could have very little area if the decay vertex and pion fiber are on the same row of the target, we will also search for any PV' fibers that are within 1.02 cm of the decay vertex. So close to the decay vertex, but still adjacent to a kaon fiber.

The end result is that *kpi_gap* is a tighter version of $\overline{TARGF}$, such that *kpi_gap* $\approx \overline{TARGF}\cdot$(cut events with in time PV fibers near decay vertex). With this new tool, the 58 events were scanned and classified. Table 4 shows a quick breakdown on how the events were classified.

Type	**# of events**	**Comments**
bad run	1	BWPC off
kpi_gap	23	All 18 are kinks and 1 is a possible kink, not a 2bm.
+*tgzfool*	21	Events that pass *kpi_gap* , but fail $tgz < -5$.
kinks	1	Did not get removed by *kpi_gap* .
KIC	1	2-beam event where one particle emerges from the Range Stack.
unknown	2	Most likely 2-beam, but not very clear.
2-beam	8	Does not include ones removed by *tgzfool*/*kpi_gap*
Total	58	

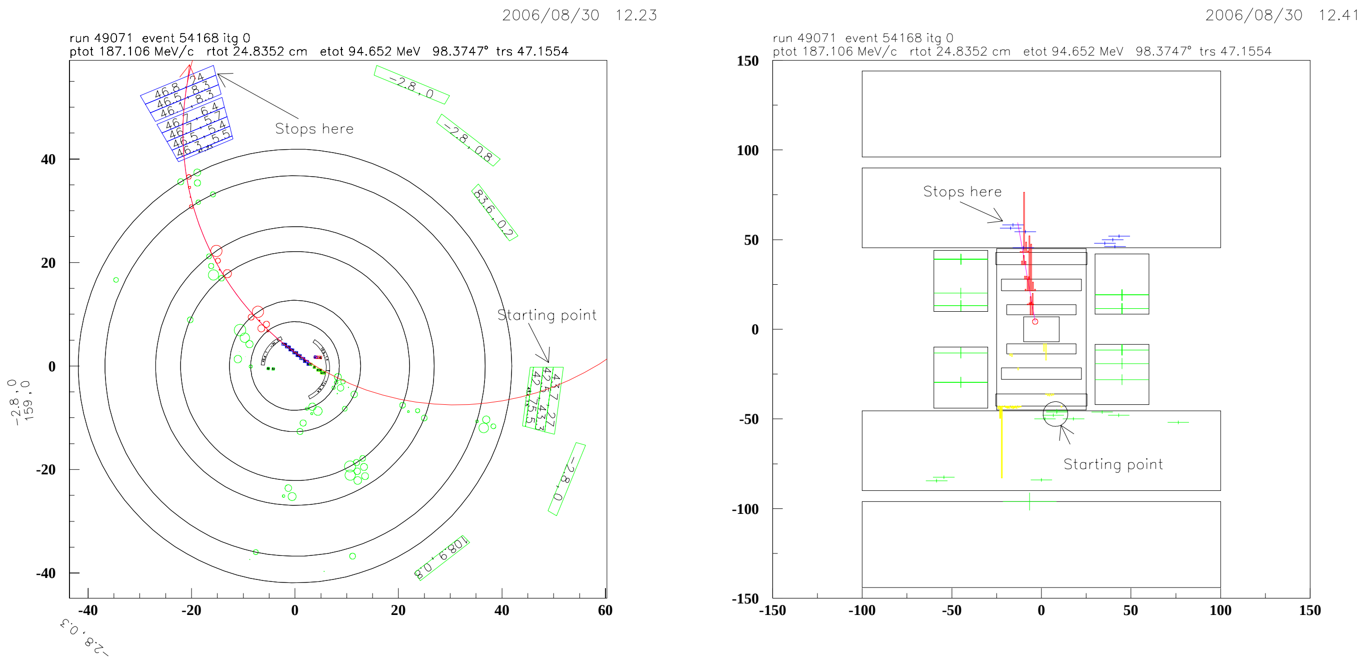
Table 4: Classification of events that survive the initial 2-beam KK rejection cuts (tagging with $\overline{TARGF}$. In the 1/3 PNN1+PNN2 sample before the PNN2 trigger change.

- The 'bad run' event was due to the beam-wire chambers being off. Further details about this event is located in technote k0??
- 23 events are Tg-scatters and were found by *kpi_gap* , so they are able to be removed from the sample.
- 21 events passed *kpi_gap* but failed the cut $tgz < -5.cm$, which is the E787-PNN2 cut (E949-PNN1 had the *tgzfool* cut set at -15.0cm. We are implementing this cut to remove pions that scatter in the B4 which causes the trigger. We do not want to accept events where the pions come from outside the TG in any case.
- 1 TG-scattered event was not removed by *kpi_gap* . This event is detail in a later section.
- 11 events are 2-beam.

3.1.2 KIC event

The pion track in event 54168 run 49071 starts in the Range Stack (RS) and passes thru the Target (TG) and creates the $T \bullet 2$ trigger on opposite side of the RS as seen in Figures 4 and 4. The initial hits in the RS occur at $t \sim 43.ns$ and the time of the $T \bullet 2$ trigger is $\sim 47.ns$. This is a difference of $\sim 4.ns$ which is the time it takes to traverse the UTC chamber distance. We have to manually determine the total energy and range, due to the incorrect reconstruction. $E_{total} \geq 102.MeV$ there is an unknown amount of energy in the initial RS-cluster. $R_{total} \approx 29.cm$. The total range and energy is consistent with a $K_{\pi 2}$ decay. This would indicate that an initial Kaon at $t \sim 0.ns$ stopped in the TG and then another Kaon entered the detector at $\sim 43.0ns$ and promptly decays. The π^+ traverses the UTC and TG and comes to rest in the RS on the other side of the detector.

There are 14 hits at 43.ns (-4.17ns relative to *trs*) in the Cerenkov counter. CKTRS (*ckt_rs.function*) basically cuts the event if we have 5 or more hits within 2ns of *trs*. Since the second K^+ enters 4ns before the $T \bullet 2$ trigger CKTRS does not remove this event. We also see the second K^+ in both BW chambers.



(a) xy-view (b) z-view

Figure 4: KIC Event. The red curve is the UTC extrapolation.

The K^+ is not observed in the Active Degrader (AD). So we must assume that the K^+ somehow scatters into the RS after BW-2 and before the AD. So this event is a 2-beam KK event since the second K seems to initially come from the beamline and then scatters into the fiducial region. However, the B4 hit that flags this event is only located in one plane (U10) of the B4. There are two hits in element U10. One hit at -1.0ns and another at 44.98ns both have a recorded energy of 1.47019MeV (note that the B4 energy cut in the KK branch is [1.1,5.0]). The energies are identical. The CCD channel was unable to discern the second hit and so both hits are given the same energy. So the true energy of the second hit, which causes the flag, could have very small.

3.1.3 Remaining kink event

The only event of the 58 that was identified visually as a TG-scatter (kink) and was unable to be removed by *kpi_gap* is event 129159 run 48435. This events shows a possible loophole in the analysis that needs to be carefully investigated. The loophole is when the second beam particle comes into the detector between beam-time and *trs*.

The following description of the event goes along with Figure 5.

- The first Kaon enters the TG and is observed by the B4 detector at about 2ns.
- A second Kaon enters the TG and is observed by the B4 detector at about 6ns. Because the second K^+ is within the swath *swathccd* identifies it as the Kaon whose product produces the $T \bullet 2$ trigger.
- The first K^+ decays at $\sim 13ns$ travels over 4cm in the target and scatters and ultimatily creates the $T \bullet 2$ trigger.

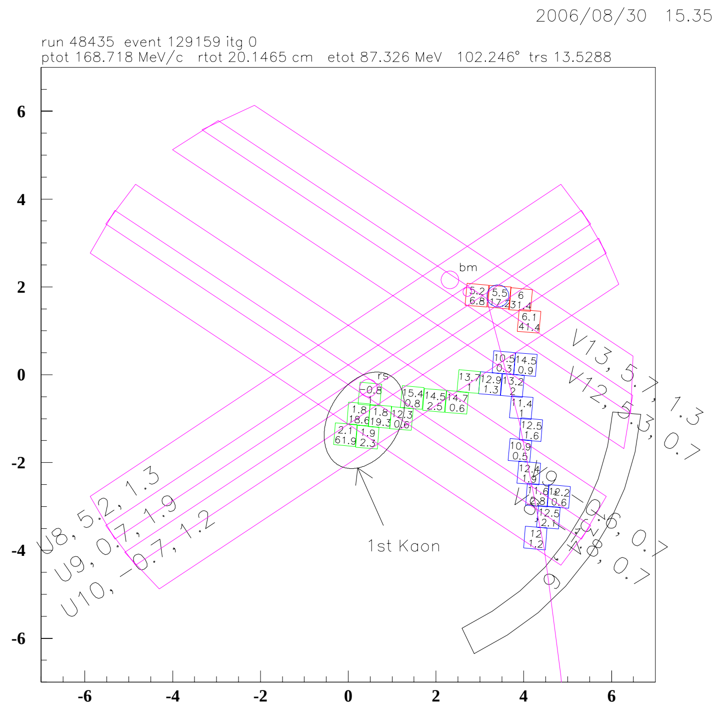


Figure 5: View of the TG with the B4 detector overlayed. Kinked event which *kpi_gap* is not able to find.

- $\overline{b4ccd}$ is what flags this event for the 2-beam rejection sample. This lead to an investigation of the *b4ccd* cut. See section ?? which gives further details.
- A hit with 133 counts ($\sim ???MeV$) in the AD at *trs*.
- This event fails *ccdpul*. The ccdfiber observes 2MeV around 16ns. This could possibly be some type of conversion of the first K^+'s decay.

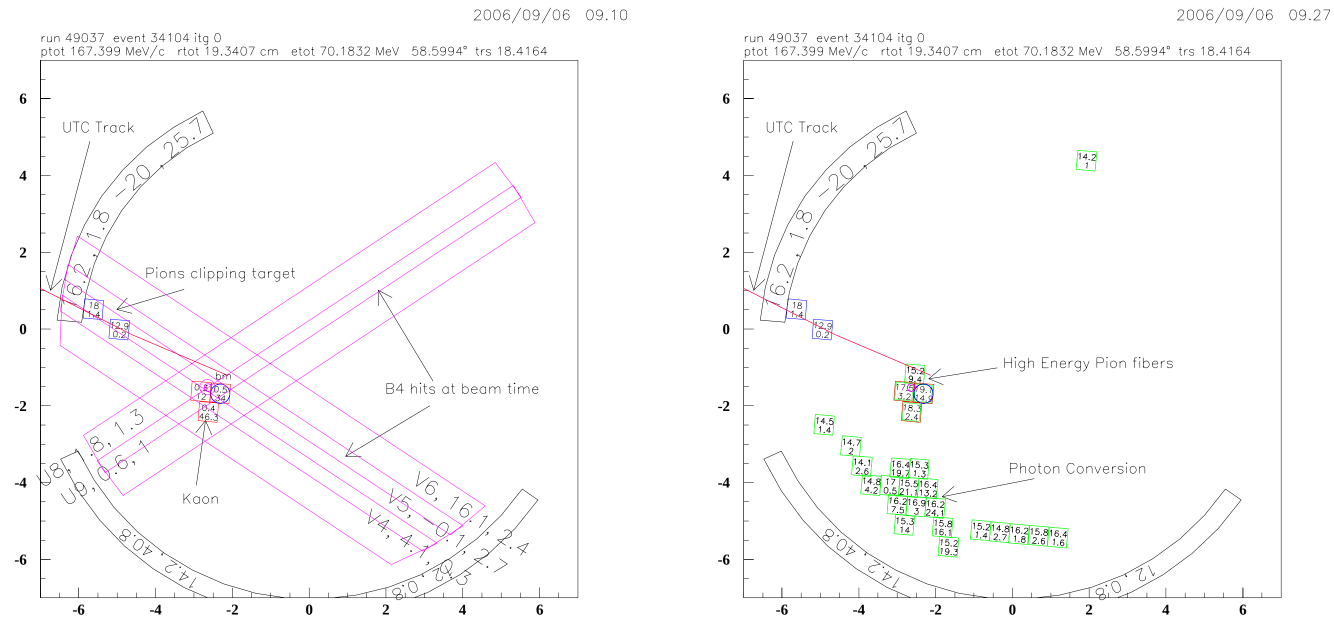
3.1.4 *b4ccd.function*

The *b4ccd.function* used during the PNN1 analysis had a problem with the algorithm's clustering of hits in the same plane. The algorithm would only add a hit to the cluster if it was in time and adjacent to the first hit in the cluster. The correct method would allow a hit adjacent to any element in the cluster. The PNN1 method would be dependent on the original ordering of the hits in the element. The error has been corrected. No additional events were observed in the KK 2-beam rejection branch after the correction.

Another potential problem is the 'averaging' the total area of the cluster's pulse. This does not seem correct to do this. However, the cut requires a minimum of 500 units of total energy and this could have been optimized with using the 'average' pulse area.

3.1.5 What we want to avoid! A look at a prime $K_{\pi 2}$-scatter event.

Event 34104 run 49037 is no longer tagged in the 2-beam KK rejection sample due to *kpi_gap* not allowing PV fibers adjacent to the Kaon fibers. The event is documented here because it is an ideal



(a) Kaon and Pions in Target

(b) z-going Pions and Photons in Target

Figure 6: Run 49037 event 34104. An example of a $K_{\pi 2}$ *target scatter*.

example of a $K_{\pi 2}$ *target scatter*, the largest background in PNN2 . We can reconstruct the event as follows:

- Incoming K creates hits in all beam detectors (B4 and TG hits seen in Figure 6(a)) and comes to rest after 92MeV in the TG.
- In Figure 6(b) you can see the that there are very high-energy fibers in time with *trs* in the kaon fibers.
- We know that the particle emerging from the Kaon is traveling upstream because we see the UTC track extrapolate into the B4 counter in Figure 7. The Pion scatters in B4 into the fiducial region and creates a false tag in the B4 at *trs* (removed by requiring *kpi_gap*).
- The Pion traverses the edge of the TG to give some pion hits in the TG, which is require in PNN2.
- We observe a photon conversion in the TG in Figure 6(b). The TG is able to contain the entire energy of the photon since the photon is traveling in the downstream z-direction, opposite the Pion.

3.2 Kaon-π (Kpi)

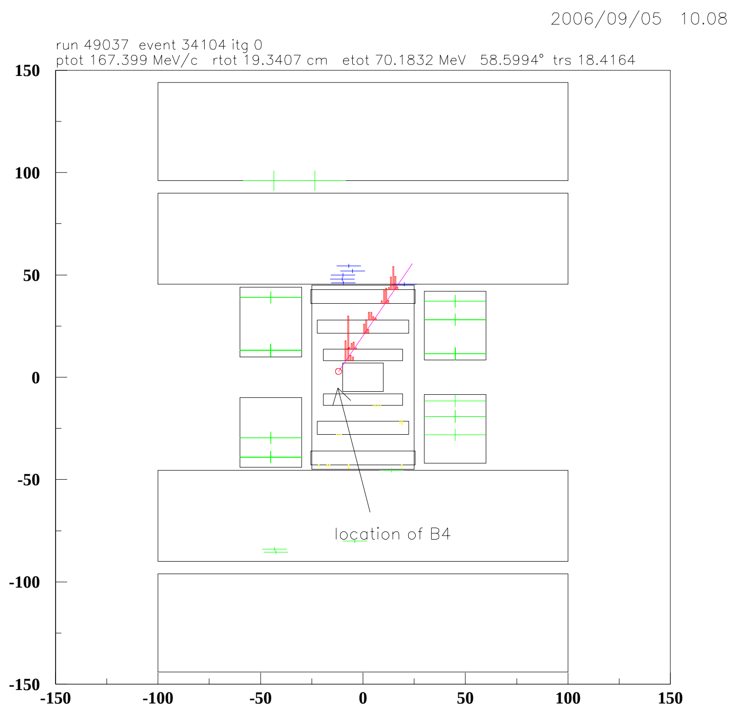


Figure 7: Z-View of Run 49037 event 34104. The orgin of the π is in the B4-counter (outside of the target. Also, note that the UTC track clips the edge of the target which we see in Figure 6 in the form of 2 pion fibers.

4 Estimate

$rejection\ (n)$	1st half	2nd half	PNN2(1/3)
$Rej_{K-K}:\ BWTRS \cdot CkTRS \cdot CkTail$	43.8 ± 12.0 (13)	76.6 ± 19.0 (16)	**61.9±11.4 (29)**
$Rej_{K-pi}:\ BWTRS \cdot CpiTRS \cdot CpiTail$	339.7 ± 138.5 (6)	117.1 ± 30.1 (15)	180.7 ± 39.3 (21)

Table 5: **2-Beam Rejection Summary**. First number is the rejection. The number in parenthesis is the number of events remaining that the rejection is based upon. K-K is the case where two Kaons are entering the beam. K-pi is the case where we have a Kaon and a Pion entering. $\overline{B4TRS \cdot B4CCD}$ is applied.

$Norm.\ branches$	1st half	2nd half	PNN2(1/3)
$K\text{-}K_n:\ B4TRS \cdot B4CCD$	1.0 ± 1.0	1.0 ± 1.0	**1.0 ± 1.0**
$K\text{-}K_r:\ TG \cdot TGKIN \cdot TGPV$	2.0 ± 1.4	1.0 ± 0.0	**3.0 ± 2.4**
$K\text{-}pi_n:\ B4TRS \cdot B4CCD$	1.0 ± 1.0	2.0 ± 1.4	2.0 ± 1.4
$K\text{-}pi_r:\ TG \cdot TGKIN \cdot TGPV$	12.0 ± 11.5	18.0 ± 17.5	30.0 ± 29.5
N_{K-K}	0.5 ± 0.6	1.0 ± 1.0	**0.3 ± 0.4**
N_{K-pi}	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1

Table 6: **2-Beam Normalization Summary**. The 2-BM Normalization has 2 branches that are further bifurcated. $K\text{-}K_{r,n}$, $K\text{-}pi_{r,n}$ are the results of the bifurcations, r=rejection, n=normalization, which we used to determine the last two rows. N_{K-K} *and* N_{K-pi} are the 2-BM normalization values which are used in combination with Table 3 to give the final background in Table 5. For KK (Kpi), $\overline{CkTRS \cdot CkTAIL \cdot BWTRS}$ ($\overline{CpiTRS \cdot CpiTAIL \cdot BWTRS}$) is applied

$Bkgrnd$ ($\times 10^{-3}$)	k034	e787	1st half	2nd half	PNN2(1/3)
1-BM	3.86 ± 2.36	1.66 ± 1.66	0.77 ± 0.77	1.52 ± 1.52	**0.51± 0.5**
2-BM KK	0.983 ± 0.983	145.9 ± 145.9	34.27 ± 43.01	39.15 ± 40.34	**16.16 ± 21.07**
2-BM Kpi	0.106 ± 0.106	19.7 ± 19.7	**0.74 ± 1.06**	2.85 ± 3.50	1.11 ± 1.36
2-BM	1.14 ± 1.14	165.6 ± 165.6	35.01 ± 35.01	42.00 ± 40.50	17.26 ± 17.26
$Total$	5.00 ± 2.62	167.3 ± 167.3	35.78 ± 35.78	43.52 ± 40.55	17.77 ± 17.77

Table 7: **Total Background.** Scaled to the 3/3 sample. k034 column is the result of e949-pnn1 analysis. e787 is the result of the e787-PNN2 analysis. The other columns are current results that are expanded upon throughout the rest of the tables. The errors are statistical. KB_{live} for k034 is 1.77×10^{12} and for e787 is 1.71×10^{12} . e787 background has been scaled up accordingly for comparison purposes.

$rejection\ (n)$	p11	p12	p1all
$Rej_{K-K}:\ BWTRS\cdot CkTRS\cdot CkTail$	75.0 ± 74.5 (1)	152.0 ± 151.5 (1)	113.5 ± 79.9 (2)
$Rej_{K-pi}:\ BWTRS\cdot CpiTRS\cdot CpiTail$	2023.0 ± 2022.5 (1)	7171.0 ± 7170.5 (1)	9194.0 ± 9193.5 (1)

Table 8: **PNN1: 2-Beam Rejection Summary** of Tables 14-15. First number is the rejection. The number in parenthesis is the number of events remaining that the rejection is based upon. K-K is the case where two Kaons are entering the beam. K-pi is the case where we have a Kaon and a Pion entering. $\overline{B4TRS\cdot B4CCD}$ is applied.

$Norm.\ branches$	p11	p12	p1all
$K\text{-}K_n:\ B4TRS\cdot B4CCD$	1.0 ± 0.0	1.0 ± 0.0	1.0 ± 0.0
$K\text{-}K_r:\ TG\cdot TGKIN\cdot TGPV$	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
$K\text{-}pi_n:\ B4TRS\cdot B4CCD$	1.0 ± 1.0	1.0 ± 1.0	1.0 ± 1.0
$K\text{-}pi_r:\ TG\cdot TGKIN\cdot TGPV$	9.0 ± 8.5	25.0 ± 24.5	34.0 ± 33.5
N_{K-K}	1.0 ± 0.0	1.0 ± 0.0	1.0 ± 0.0
N_{K-pi}	0.1 ± 0.2	0.0 ± 0.1	0.0 ± 0.0

Table 9: **PNN1: 2-Beam Normalization Summary** of Tables 16-19. The 2-BM Normalization has 2 branches that are further bifurcated. $K\text{-}K_{r,n}$, $K\text{-}pi_{r,n}$ are the results of the bifurcations, r=rejection, n=normalization, which we used to determine the last two rows. N_{K-K} *and* N_{K-pi} are the 2-BM normalization values which are used in combination with Table 3 to give the final background in Table 5. For KK (Kpi), $\overline{CkTRS\cdot CkTAIL\cdot BWTRS}$ ($\overline{CpiTRS\cdot CpiTAIL\cdot BWTRS}$) is applied

$Bkgrnd$ ($\times 10^{-3}$)	k034	e787	1st half	2nd half	PNN2(1/3)
1-BM	3.86 ± 2.36	1.66 ± 1.66	0.77 ± 0.77	1.52 ± 1.52	$\mathbf{0.09 \pm 0.09}$
2-BM KK	0.983 ± 0.983	145.9 ± 145.9	34.27 ± 43.01	39.15 ± 40.34	$\mathbf{2.89 \pm 2.89}$
2-BM Kpi	0.106 ± 0.106	19.7 ± 19.7	$\mathbf{0.74 \pm 1.06}$	2.85 ± 3.50	1.11 ± 1.36
2-BM Kpi KB_{Live}				$\mathbf{1.14 \pm 1.14}$	$\mathbf{1.88 \pm 1.88}$
2-BM Kpi $PNN1_{scale}$				$<$ 1st half	
2-BM	1.14 ± 1.14	165.6 ± 165.6	35.01 ± 35.01	42.00 ± 40.50	$\mathbf{4.77 \pm 4.77}$
$Total$	5.00 ± 2.62	167.3 ± 167.3	35.78 ± 35.78	43.52 ± 40.55	$\mathbf{4.86 \pm 4.86}$

Table 10: **Total Background.** Scaled to the 3/3 sample. k034 column is the result of e949-pnn1 analysis. e787 is the result of the e787-PNN2 analysis. The other columns are current results that are expanded upon throughout the rest of the tables. The errors are statistical. KB_{live} for k034 is 1.77×10^{12} and for e787 is 1.71×10^{12} . e787 background has been scaled up accordingly for comparison purposes.