1 Background Study

This is a brief note about the 2/3 study of the 1997 PNN2 analysis. The Technote for this analysis will be completed during the next 15 days or so. At least I will complete it before the Collaboration meeting at BNL in Feb.

Table 1 shows the normalization branch of the $K_{\pi 2}$ scatter(tg) background study for the 1997 PNN2 analysis using both 1/3 and 2/3 sample. For reference, the results from the 1996 PNN2 analysis are also shown. For the normalization of the $K_{\pi 2}$ background study, the event sample was selected by reversing the Photon Veto cut everywhere except in the Target and by applying the Target Photon Veto cut and the lead glass cut. The event sample also had to pass the reconstruction cuts, kinematic cuts, piscat cuts and the TDCUT1.

Table 2 shows the Photon Veto study for the 1997 analysis using both 1/3 and 2/3 sample. Also shown are the results from the 1996 analysis. For the Photon Veto study we made 17 classes of events in order to cleanly tag events which scattered in the target. The details from all the classes will be presented in the final Technote. However, due to some time constraint, I am presenting the results from the Class 17 only which was found to be the best statistically and was used as the final Photon Veto rejection in both 1996 and 1997 analysis. Class 17 events were selected by reversing the CCDPUL cut, CHI567, VERRNG cuts. Therefore, using the Photon Veto rejection from the class 17 events the $K_{\pi 2}$ scatter (tg) background can be calculated as:

from the 1/3 sample :

$$N_{bck} = \frac{3\times 19}{221.22\pm 73.57} = 0.2579 \pm 0.085$$

And from the 2/3 sample:

$$N_{bck} = \frac{1.5\times 49}{186.68\pm 39.69} = 0.3937 \pm 0.084$$

Though the $K_{\pi 2}$ scatter (tg) background is higher in the 2/3 sample, it is within statistics.

The remaining backgrounds in the PNN2 analysis are negligible as compared to the $K_{\pi 2}$ scatter (tg) background. The details of the other background study will be presented in the final Technote. Here, only the final background numbers are presented which is shown in Table 3.

2 Single Cut Failure Study

5 events were found in the 2/3 sample which failed only a single cut. Table 4 summarizes the cuts failed by these five events and also summatizes how badly they failed these cuts. One event was found to have failed the Photon Veto cut on the upstream inner ring of the End Cap with about 14.08 MeV of photon energy at track time. Two events were found to have failed the CCDPUL cut. These two events deposited about 5.14 MeV and 2.18 MeV of second pulse energy at pion time in the Vertex fiber (K-decay fiber). The CCDPUL cut rejects events if the second pulse energy at

CUT	1996 1/3 Sample	 2/3 Sample	1997 1/3 Sample	 2/3 Sample
SETUP	5496	11389	2768	5465
B4TIM	5079	10581	2650	5266
B4EKZ	3240	6598	1656	3312
B4EKZ_IC	3201	6522	1646	3274
TGZFOOL	3187	6489	1637	3258
EPITG	2127	4319	1049	2114
EPIMAXK	2127	4318	1049	2114
TARGF	2057	4159	1022	2048
DTGTTP	2054	4153	1017	2039
RTDIF	2052	4140	1015	2034
DRP	2050	4126	1012	2022
TGKTIM	1907	3846	932	1886
EIC	1876	3774	917	1849
TIC	1876	3774	917	1849
TGEDGE	1838	3710	899	1813
TGDEDX	1600	3231	776	1555
TGENR	1518	3062	736	1466
PIGAP	1493	2994	724	1444
TGB4	1403	2798	674	1346
PHIVTX	1176	2392	574	1119
OPSVETO	1176	2392	574	1119
TIMKF	986	1936	500	956
CCDPUL	112	250	66	129
DELCO6	62	161	45	99
CHI567	43	115	32	65
NPITG	43	115	32	65
VERRNG	33	73	20	49
CHI5MAX	33	72	19	49
ANGLI	32	72	19	49
ALLKFIT	29	67	19	49
TPICS	29	67	19	49
KIC	29	67	19	49
EPIONK	29	67	19	49

Table 1: Normalization Table for the $K_{\pi 2}$ scatter (tg) Background study.

PV Rejection (Class 17)	1996		1997	
	1/3 Sample	2/3 Sample	1/3 Sample	2/3 Sample
NORM	3991	8165	1991	4107
HEX	3991	8165	1991	4107
RDP1	3991	8165	1991	4107
BV0N	3991	8165	1991	4107
ECON	3991	8165	1991	4107
TG	3991	8165	1991	4107
IC	3732	7655	1850	3851
VC	3383	6934	1633	3449
CO	2097	4349	986	2029
CM	2068	4295	969	1999
EC_IU	1293	2705	678	1389
EC_ID	1094	2321	583	1162
SG	198	425	79	130
RD	101	227	46	86
BV	78	176	36	67
EC	16	50	9	22

Table 2: Photon Veto study for the 1997 PNN2 analysis. For reference, the results from 1996 analysis are also shown.

	1996(1/3)	1996(2/3)	1997(1/3)	1997 (2/3)
$K_{\pi 2}$-scat(TG)	0.35 ± 0.10	0.62 ± 0.17	0.2579 ± 0.085	0.3937 ± 0.084
$K_{\pi 2}$-scat(RS)	0.004 ± 0.006	0.007 ± 0.007	0	0.005 ± 0.003
$K^+ \to \pi^+ \pi^0 \gamma$	0.022 ± 0.004	0.027 ± 0.004	0.009 ± 0.002	0.006 ± 0.002
Muon Back	0.011 ± 0.011	0.007 ± 0.007	0.008 ± 0.008	0.009 ± 0.009
1-beam	0.0009 ± 0.0009	0.0003 ± 0.0003	0.0007 ± 0.0007	0.0003 ± 0.0003
2-beam	0.050 ± 0.050 (KK)	0.031 ± 0.031 (KK)	0.091 ± 0.091 (KK)	0.030 ± 0.030
	0.006 ± 0.006 (KP)	0.002 ± 0.002 (KP)	0.013 ± 0.013 (KP)	0.003 ± 0.003
KE4	0.051 ± 0.062	0.026 ± 0.032	0.051 ± 0.051	0.026 ± 0.026
CEX	0.011 ± 0.011	0.011 ± 0.011	0.012 ± 0.012	0.012 ± 0.012
Total	0.506 ± 0.131	0.731 ± 0.177	0.443 ± 0.136	0.485 ± 0.094

Table 3: Final Background Table for the 1997 analysis using both 1/3 and 2/3 sample. Also shown are the background table from the 1996 PNN2 analysis.

Event	Cut failed	How Badly
Run: 34701, Event: 32840	EC_IU	14.08 MeV
Run: 35111, Event: 11192	CCDPUL	5.14 MeV in Vertex fiber
Run: 35177, Event: 3127	CCDPUL	2.18 MeV Vertex fiber
Run: 35178, Event: 101810	TGPV	69.47 MeV
Run: 35250, Event: 25988	RNGMOM	17.99 (Cut is at 2)

Table 4: These 5 events failed only a single in the 2/3 sample for the 1997 PNN2 analysis.

pion time is greater than 1.5 MeV for both Vertex and Non-vertex fibers. One event was found to have failed the target Photon Veto cut with about 69.47 MeV of Photon Energy at track time. All these events are consistent with the expected $K_{\pi 2}$ scatter background in the target. The fifth event was found to have failed the RNGMOM cut. The χ^2 like quantity which was formed by the subtracting the expected range from the measured range in the range stack returns a value of 17.99 which signifies that this event is dip into the muon band. The cut to remove the muon band events is at 2 for the χ^2 like quantity. Considering the large rejection of the RNGMOM cut this fifth event is also consistent with the expected muon background. The rejection of RNGMOM cut was found to be 66/0 in the 2/3 sample and this sample (to measure RNGMOM rejection) was selected by reversing the TDCUT1 (Details will be in the full Technote).

3 Outside the Box Study

Figure 1 shows the range momentum plot for the Outside the Box study. The top plot is from the 1/3 sample and the bottom plot is from the 2/3 sample for the 1997 data set. All the cuts were applied in these plots while masking out the PNN2 signal region. The photon veto rejection for the $K_{\pi 2}$ box events was found to be larger in the 2/3 sample as compared to the 1/3 sample in the 1997 PNN2 analysis. No event was found which is close to the PNN2 signal region in this study.

4 Examining 2 to 6ns region

For the PNN2 analysis the DELCO cut was set at 6ns. Therefore, the 2 to 6ns region for DELCO can be studied to find the expected number of events in the signal region. Figure 2 shows the range vs momentum plot for all the events which survived all the analysis cut in the 2 to 6ns region. The top plot is for the 1/3 sample and the bottom plot is for the 2/3 sample. As it is clear, no event was found in the 2 to 6ns region both in the 1/3 and the 2/3 sample.

The following simple prescription can be applied to find the expected number of events in the 2 to 6ns region. Figure 3 shows the rejection (top plot) and the relative acceptance (bottom plot) of the CCDPUL cut in the 2 to 6ns region and above the 6ns region. No other cut is so highly

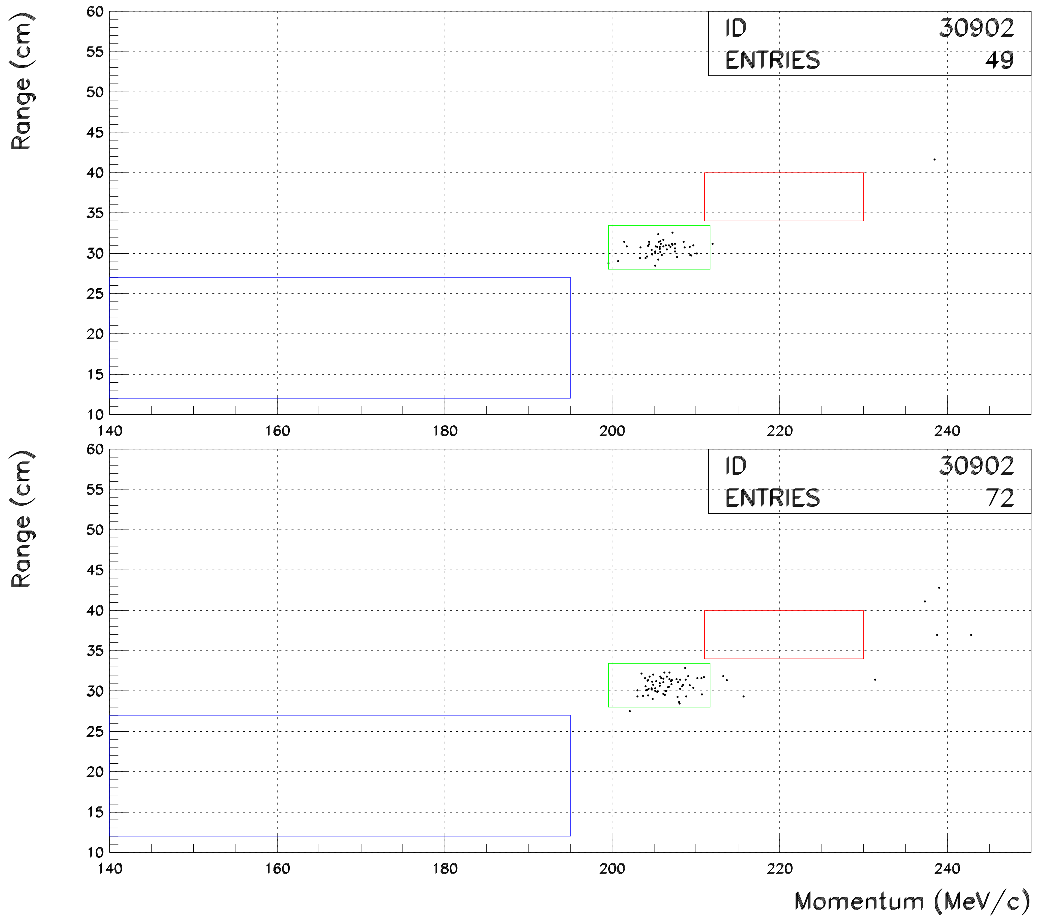

Figure 1: Outside the BOX study using the 2/3 sample. The PNN2BOX was masked out.

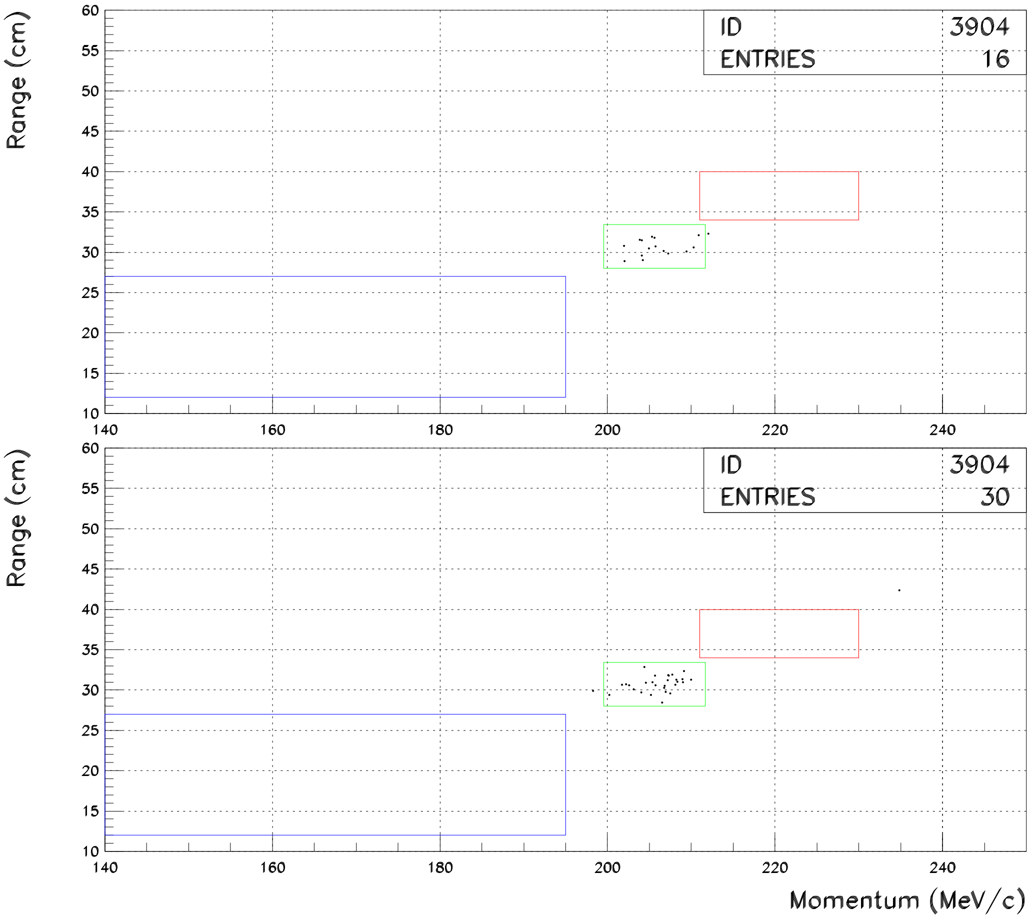

Figure 2: Examining 2 to 6 ns region for delayed coincidence using the 2/3 sample. 2 to 6 ns region was examined. No event was found in the PNN2BOX in that region.

	1996 PNN2	1997 PNN2 (NEW)
A_{UMC}	0.0808 ± 0.001	0.0808 ± 0.001
A_{KM21}	0.0401 ± 0.0005	0.0536 ± 0.005
A_{TD}	0.5448 ± 0.0040	0.4904 ± 0.0037
A_{KIN}	0.8348 ± 0.0038	0.8595 ± 0.0022
A_{TGKIN}	0.8223 ± 0.0037	0.8115 ± 0.0020
A_{SWATH}	0.9820 ± 0.001	0.9820 ± 0.001
A_{TOT}	$(1.190 \pm 0.018) \times 10^{-3}$	$(1.456 \pm 0.02) \times 10^{-3}$
SES	$(1.169 \pm 0.029) \times 10^{-9}$	$(1.667 \pm 0.023) \times 10^{-9}$

Table 5: All acceptance factors for PNN2 analysis.

correlated to DELCO as the CCDPUL cut. Therefore, the following calculation is expected to be correct in the first order. From the top plot in Figure 3, the rejection of the CCDPUL cut in the 2 to 6ns region was found to be 133/21 = 6.33 and above the 6ns region it was found to be 367/45 = 8.16. The $K_{\pi 2}$ box events can be used to estimate the relative acceptance of the CCDPUL cut in the 2 to 6ns region and above the 6 ns region which is shown in the bottom plot in Figure 3 from which the relative acceptance of the fiducial region was calculated to be 5555/1038 = 5.35. Therefore, had we observed one event in the 2 to 6 ns region, we would have expected

$$1 \times \frac{6.33}{8.16} \times 5.35 = 4.2$$

of an event in the signal region. Conversely, for each event in the signal region we would expect to see 0.241 of an event in the 2 to 6ns region. Therefore, based on the expected amount of background of 0.485 in the signal region, the amount of background expected in the 2 to 6ns region is 0.12 of an event. Therefore, the observation of 0 events in the 2 to 6ns region is consistent with its high probability.

5 Acceptance and SES

Table 5 shows the the final acceptance table and also the results for SES for the 1997 PNN2 analysis. Also shown are the results from the 1996 PNN2 analysis for reader's information. The higher acceptance for A_{KM21} is mainly coming from lead glass cut, CCDPUL cut and DELCO6 cut. The loss of acceptance in A_{TD} is mainly due to L1.1 which was not performing as expected during the 1997 run. The details of these acceptance calculations will be provided in the final Technote.

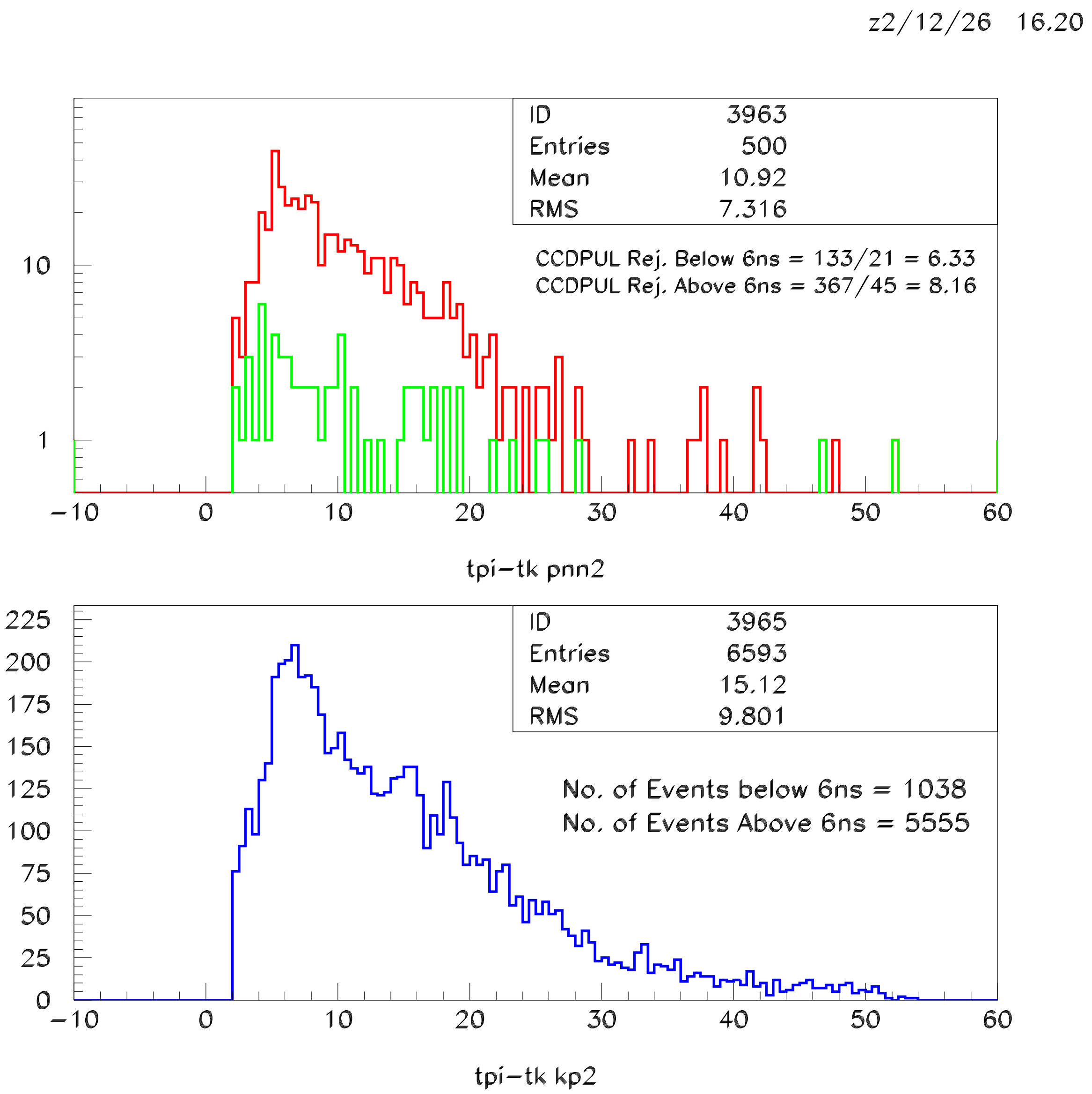

Figure 3: The rejection and relative acceptance of the CCDPUL cut in the 2 to 6ns region and above the 6ns region region for DELCO.