Overview of the pnn2 analysis
David Jaffe 2-3 May 2006

Meeting agenda
• Overview (David)
• Kpi2-scatter background
  • Photon veto (Ilektra)
  • CCDPUL (Joss)
• Beam background (Benji)
• MC & related backgrounds (Wang Zhe)
• Analysis schedule (David)
• Discussion
Start from status as of 18 August 2005

pnn2 analysis

Basics

1. Use pnn1 cuts as baseline for comparison/validation if possible
2. Attain previous pnn2 S/B \sim 1/7
3. Can we increase R and/or A?

Strategy

1. pnn2 cuts start from pnn1 cuts \hspace{1cm} \text{Done}
2. Modifications based on Bipul/Milind analyses \hspace{1cm} \text{In progress}
3. Check R,A of each cut \hspace{1cm} \text{In progress}
Reminder of backgrounds from Bipul’s 1997 analysis:

<table>
<thead>
<tr>
<th>Bkgd</th>
<th>1997(2/3)</th>
<th>? Tools</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_{\pi^2}-\text{scat}$</td>
<td>0.39 ± 0.15</td>
<td>PV CCD</td>
<td>In progress</td>
</tr>
<tr>
<td>$K_{\pi^2\gamma}$</td>
<td>0.006 ± 0.002</td>
<td>MC PV</td>
<td>Machinery in place</td>
</tr>
<tr>
<td>$\mu$</td>
<td>0.009 ± 0.009</td>
<td>PV TD</td>
<td>Not yet begun</td>
</tr>
<tr>
<td>2beam KK</td>
<td>0.030 ± 0.030</td>
<td>timing PID</td>
<td>.14</td>
</tr>
<tr>
<td>2beam $K\pi$</td>
<td>0.003 ± 0.003</td>
<td>timing PID</td>
<td>.009</td>
</tr>
<tr>
<td>$K_{e4}$</td>
<td>0.026 ± 0.026</td>
<td>MC PV CCD</td>
<td>In progress</td>
</tr>
<tr>
<td>CEX</td>
<td>0.013 ± 0.013</td>
<td>MC timing PV</td>
<td>In progress</td>
</tr>
</tbody>
</table>

1beam bkgd was negligible

Background numbers are preliminary, we’ll hear about them at this meeting.
Photon veto (Ilektra, Dima)

1. Verify R vs A on pnn1 2/3  
   K-050, Dima

2. Prepare kink sample (max kink events ~ 10K)  
   Done, Benji & Ilektra

3. Measure R(PV pnn1) on kink sample (baseline)  
   Done, Ilektra

4. Tune PV on kink sample to create PV(pnn2)
   - Early BV hits  
     Done, Ilektra
   - BVL TD hits  
     Done, Dima
   - AD  
     In progress, Ilektra
   - other?  
     Re-optimize PV with AD incl., kerror treatment, Ilektra

5. Measure R(PV pnn2) on CCDPUL sample  
   No validated CCDPUL cut

There is probably a gain of ~1.1 in R*A by rejecting events with apparent hardware errors “kerror” (Jim, Ilektra)

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K-045 “Study of target CCD pulse fitting analysis”

CCDPUL (Jim) → Joe, Joss

1. Examine/modify CCDPUL cut components to take into account new fitter   In progress, Joss

2. Measure R on $\overline{PV(pmn1)}$ and A on $K_{\mu2}$ sample   Not yet

3. Bipul increased A by $\sim 10\%$ (relative) to $\sim 0.43$ while maintaining R. Can we do better?   Maybe we should be satisfied with doing as well as Bipul
TD/μ background (Sasha)

1. I estimate we can gain ~ 5% acceptance by loosening TD cuts based on Bipul’s and Tetsuro’s theses (gain in 2002 FITPI is offset by L1.n losses due to higher rate)

2. Verify $A(TD \text{ pnn1})$ on pnn1 2/3 sample  
   K-051, Sasha

3. Measure pnn2 μ-bkgd with pnn1 TD cuts  
   Not yet begun

4. Remove/loosen EV5, TDVARNN, ELVETO cuts and remeasure pnn2 μ bkgd  
   Not yet begun

Perhaps we should be satisfied with the pnn1 TD acceptance
Signal box size (?)  Wang Zhe

1. Generate signal MC (can we use pnn1 signal MC?)  Done, Wang Zhe
2. Assess potential acceptance gain by loosening P,R,E, cuts  Done, Wang Zhe
3. Assess potential acceptance gain by loosening DELCO cut  In progress
4. Define and blind “large box” that includes current (P,R,E,DELCO) signal box  Done

UMC based $\pi \nu \bar{\nu}$ (2) efficiency (NIDIF on)

<table>
<thead>
<tr>
<th></th>
<th>this analysis</th>
<th>TN391</th>
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<tbody>
<tr>
<td>$\epsilon_{pg}$</td>
<td>0.3036 ± 0.0028</td>
<td>0.3088 ± 0.0029</td>
</tr>
<tr>
<td>Bigger BOX</td>
<td>9726</td>
<td></td>
</tr>
<tr>
<td>$\epsilon_{pg}$</td>
<td>0.3707 ± 0.0030</td>
<td></td>
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A bigger signal box will give a 22% efficiency increment on phase space cut.

http://hep.tsinghua.edu.cn/~wangzhe/e949/Sep16.ps

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Beam background (Benji)

Strategy based on assumption that 2beam background dominates.

1. Measure $N_{KK}$ and $N_{K\pi}$ with pnn1 cuts in pnn1 box  
   In progress

2. Measure $N_{KK}$ and $N_{K\pi}$ with pnn1 cuts in pnn2 box  
   In progress

3. Check rejection of pnn2 DELCO, target cuts and TGPV on  
   2beam bkgd  
   In progress

4. Measure $N_{KK}$ and $N_{K\pi}$ with pnn2 cuts in pnn2 box  
   In progress

Note: 1beam, 2beam background estimate limited by normalization  
sample (no events left)

Complication: E949 pnn2 trigger = (E787 pnn2) * (Cpibar + PS16)  
In principle, the 2beam Kpi bkgd estimate should come from  
(E787 pnn2)*PS16 which has lower statistics.
$K_{\pi 2\gamma}$ (Wang?) Wang Zhe

1. Generate $K_{\pi 2\gamma}$ MC  Done

2. Compare $K_{\pi 2\gamma}$ and $K_{\pi 2}$ A and BR  Machinery in place, await final cuts

3. Evaluate $R(PV \text{ single } \gamma)$ for radiative $\gamma$ given measured single photon inefficiency as function of angle and energy and given accepted radiative photon spectrum  Done

$K_{e4}$ and CEX background : Later

Generation of UMC samples of Ke4, CEX the same size as those used in E787 pnn2 is done.

Wang Zhe is beginning analysis of Ke4 in data using E787 techniques
Other tasks

Acceptance

*Km2-based acceptance*

*Piscat-based acceptance*

*Kp2-based acceptance*

*UMC-based pnn acceptance (MC already generated)*

*T.2 efficiency (use pnn1 results with some adjustments)*

*fs (K stopping fraction)*

*Br(Kp2) measurement as cross-check*

Outside-the-box, 1-, 2-cut failure studies

pnn branching ratio measurement

Combination of all E787 & E949 pnn results

Limit on $K^+ \rightarrow \pi^+,X$ & $\pi^+,X,Y$ (needs UMC)
Summary and comment

• A great deal of progress has been made since 18 Aug 05
• A great deal of work remains to be done and the pnn2 analysis team is and will be shrinking
• We want a correct result, but it may not be optimal ("The better is the enemy of the good." - Ed Thorndike)
Extras
### Original and bigger R,P,E signal box dimensions

<table>
<thead>
<tr>
<th>Original box</th>
<th>Bigger box</th>
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<tbody>
<tr>
<td>140 &lt; PTOT &lt; 195</td>
<td>140 &lt; PTOT &lt; 199</td>
</tr>
<tr>
<td>12 &lt; RTOT &lt; 27</td>
<td>12 &lt; RTOT &lt; 28</td>
</tr>
<tr>
<td>60 &lt; ETOT &lt; 95</td>
<td>60 &lt; ETOT &lt; 100.5</td>
</tr>
</tbody>
</table>

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