K^0_L backgrounds in the search for B^+ → K^+νν

Outline:

We studied backgrounds to B^+ → K^+νν using toy MC and BaBar MC. Toy MC allows greater statistics to break up background types. In lieu of a suitable cut on NK^0_L we use a cut on N_{IFR} = 0 which eliminates any event containing a neutral IFR cluster. Can we do better?
Study of $K^0_L$ backgrounds in generator level simulation

Separate bkgd in different types:

- **Semileptonic decays**
- **Hadronic decays containing $K^0_L$**
- **Others**
- **Signal events overlayed**

Momentum cut requires signal track with $p > 1.5$ GeV/c cuts out most of s.l. And others....... **but** many $K^0_L$ events pollute the signal region.

Overall level at which we expect to see background is 1–2 times the SM BR for $B^+ \rightarrow K^+ \nu \nu$
This shows the $K^0_L$ momentum in the lab frame using the generator level toy MC.

Note: ALL $K^0_L$ are included here not just those that are background in the previous plot.

Distribution in our bkgd’s is likely to be stiffer since they are 2 and 3–body hadronic decays.
Cut on number of neutral IFR clusters as applied in $B^+ \rightarrow K^+ \nu \nu$ analysis.

We impose a cut $N_{\text{IFR}} = 0$.

As we see, the signal to background separation is not that good, but something seems to be better than nothing.

This cut presumably removes many events with 'noise' hits in the IFR.
Using generic MC with and without the $N_{IFR}$ cut applied.

$N_{IFR} = 0$ cuts out 30% of BB events

BB in blue
CC in green
uds in red

Signal box after sideband subtraction

- $-0.2 \pm 3.4$ with $N_{IFR}$ cut
- $3.2 \pm 4.2$ without $N_{IFR}$ cut

Need more MC to distinguish these
Looking at backgrounds in the full simulation

Albeit with lower statistics this plot shows similar characteristics to those seen using the toy MC.
Summary/Conclusion

An improved $K^0_L$ veto (particularly at high–momentum) would prove useful in rejecting background for $B^+ \rightarrow K^+ \nu \nu$ and $B^+ \rightarrow \tau^+ \nu$ (.... and probably for other low multiplicity modes where there is considerable missing energy).

Using the cut on $N_{IFR}$ provides limited signal/background discrimination and unwantedly removes events.