PHYSICS IMPACT OF THE PROPOSED B1 VETO COUNTER

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ABSTRACT. A forward veto counter placed within the B1 magnet could be beneficial for some analysis. This document attempts to evaluate the gains. Several existing analyses are repeated (in Monte Carlo) with the addition of a forward counter, simulated using a Pravda MC style technique. The analyses are chosen from those most likely to benefit (using techniques where all particles are believed accounted for). In some situations, the veto seems able to provide an improvement in discrimination between signal and background.

1. Introduction

Proposed geometry changes permit the instrumentation of the B1 magnet, giving coverage of the currently uninstrumented forward region (160-300 mrads). It would then be possible to detect particles passing through this region, and to veto against events where particles are "lost". This can potentially be of use where it is believed that every single particle is accounted for in the reconstruction technique, and where the missing energy and momentum from the "lost" particle are believed to be carried away by an unobserved neutrino.

In this document the physics impact of this veto is examined. Several analyses have been chosen, and repeated (in Monte Carlo) with and without an instrumented B1. The goal in each case is to use the detection of otherwise unobserved particles to separate signal and background.

2. Detector Modeling

A Pravda MC style technique is used. Starting from MC truth, particles which pass through the active part of their detector cause a signal that varies with their type, true momentum and the parameterization of the detector. The detector is modeled with a coverage of 160 - 300 mrads.

To determine upper limit of the veto's effectiveness, its effect is first evaluated with perfect efficiency. All appropriate particles passing through the instrumented material are considered detected. To model more realistic detection rates, the energy deposited by the particles in the instrumented region is considered. This is randomly smeared, with different resolutions ($20\%/\sqrt{E}$,$50\%/\sqrt{E}$) used.

No modeling of machine noise is included.

3. Analysis

3.1. Event Sample.

A large sample of generic Monte Carlo is used.

In addition, 50k $B \to l\nu$ and 25k $B \to l\nu\gamma$ events are used. ????k $B^- \to J/\psi K^-$ events are used in the V_{ub} analysis.

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MC Type	Quantity
$B^0\overline{B^0}$	$22.25M$
B^+B^-	$74.25M$
$c\overline{c}$	$33.70M$
$u\overline{u}/d\overline{d}/s\overline{s}$	$49.70M$

TABLE 1. Generic MC sample

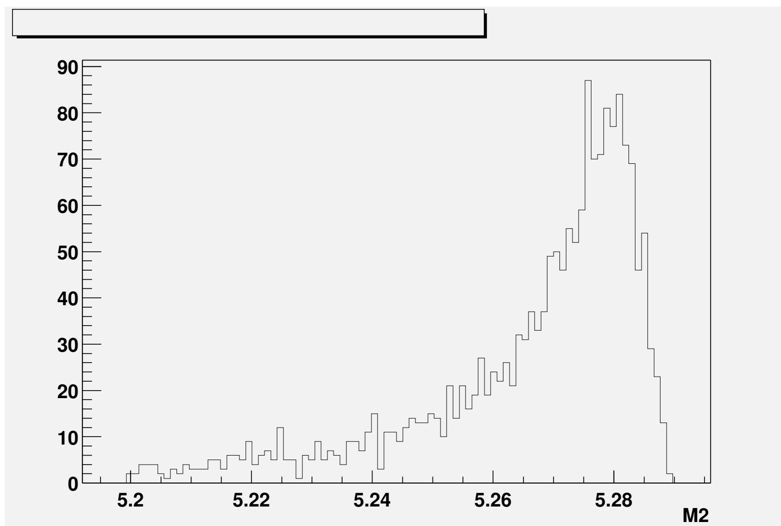

FIGURE 3.1. M_{es},$B \to l\nu$

3.2. $B \to l\nu$. This is a copy of the analysis outlined in [1].

3.2.1. *Analysis Summary.* Events are initially selected through the presence of a VeryTight lepton of $E > 2GeV$. All other particles and neutral calorimeter objects are assumed to come from the other B in the event. Their 4 momenta are summed, and used to calculate M_{es} (signal distribution shown in Fig 3.1) and ΔE (signal distribution shown in Fig 3.2) in the standard way. Only events where the charge of the fast lepton is opposite to that of the sum of charges of the rest of the particles are accepted. The energy and momentum missing from the event are calculated, and where these are inconsistent with being entirely due to a single neutrino the event is rejected. Finally, all events in which the missing momentum points close to the beam line are rejected. None of the analysis cuts are seen to be significantly correlated with the veto, except for the direction of the missing momentum in continuum events. No correlation is seen in Generic B events, perhaps because genuine fast neutrinos in the event mean that the missing momentum no longer points in the direction of a missed track.

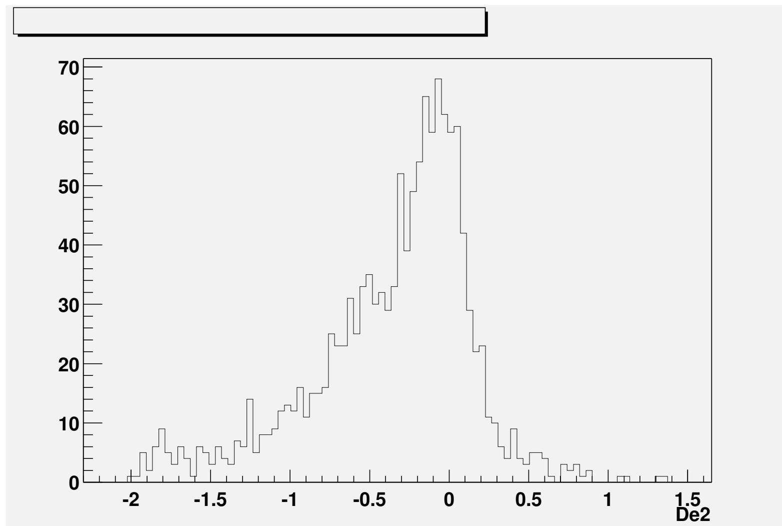

FIGURE 3.2. ΔE,$B \to l\nu$

MC	Efficiency:Perfect	Eff:20%/$\sqrt{E}$	Eff:50%/$\sqrt{E}$
$B^0\overline{B^0}$	$(29.1 \pm 8.7)\%$	$(35.9 \pm 7.8)\%$	$(41.7 \pm 7.8)\%$
B^+B^-	$(87.4 \pm 2.1)\%$	$(92.0 \pm 1.7)\%$	$(93.0 \pm 1.4)\%$
$c\overline{c}$	$(88.2 \pm 1.8)\%$	$(92.0 \pm 1.3)\%$	$(93.1 \pm 1.4)\%$
$u\overline{u}/d\overline{d}/s\overline{s}$	$(90.2 \pm 1.7)\%$	$(93.4 \pm 1.4)\%$	$(93.1 \pm 1.4)\%$
Signal	$(92.8 \pm 0.7)\%$	$(96.3 \pm 0.5)\%$	$(96.2 \pm 0.5)\%$

TABLE 2. Efficiency of Veto for $l\nu$(after all other cuts)

3.2.2. *Results.* The efficiency of a cut based on the veto (performed after all other cuts) is shown in table 3. A striking effect can again be seen in the case of $B^0\overline{B^0}$ background, with $60 - 70\%$ excluded. Signal efficiency loss is 10%, and no great discriminating power is seen against other backgrounds. The explanation could well be that the veto is most likely to be effective when a single charged particle has been lost (and seen in the forward instrumented region) from the reconstructed B - in this case the original particle must have been a B^0. In this case, the requirement for charges to be consistant means that a second track must also be lost (from the other side of the event). As a result, the chances that at least one track is going through the forward instrumented region is quite high.

This reduces the background from

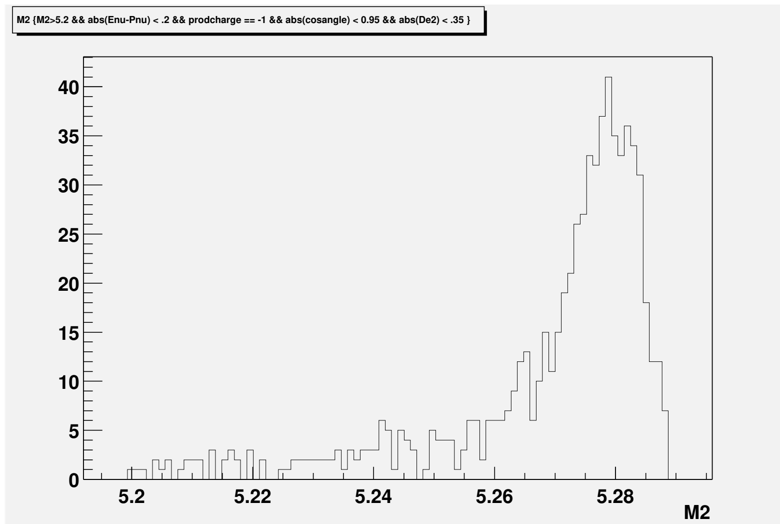

FIGURE 3.3. M_{es}, $l\nu\gamma$

3.3. $B \to l\nu\gamma$**.** This is a copy of the analysis currently being carried out by Ed Chen, Gregory P. Dubois-Felsmann, David Hitlin, as reported during the London collaboration meeting. It is similar in many respects to that shown in [2].

3.3.1. *Analysis Summary.* Events are initially selected through the presence of a VeryTight lepton of $2.58 < E < 2.78GeV$. This is combined with the highest energy photon in the event. A π^0 veto is applied (the photon is combined with all others in the event, and discarded if the invariant mass of any combination is close to that of the π^0. All other particles and neutral calorimeter objects are assumed to come from the other B in the event. Their 4 momenta are summed, and used to calculate M_{es} (signal shown in Fig 3.3) and ΔE (signal shown in Fig 3.4) in the standard way. Only events where the charge of the fast lepton is opposite to that of the sum of charges of the rest of the particles are accepted. The energy and momentum missing from the event are calculated, and where these are inconsistent with being entirely due to a single neutrino the event is rejected (a cut on $|E-p|$, shown in Fig 3.5). Finally, all events in which the missing momentum points close to the beam line are rejected.

Again the only correlation between analysis cuts and the veto is with the direction of the missing momentum in the case of continuum.

3.3.2. *Results.* The efficiency of a cut based on the veto (performed after all other cuts) is shown in table 3. A striking effect can again be seen in the case of $B^0\overline{B^0}$ background, with more than 50% excluded. Signal efficiency loss is 10%, and no great discriminating power is seen against other backgrounds. The explanation is likely to be as before.

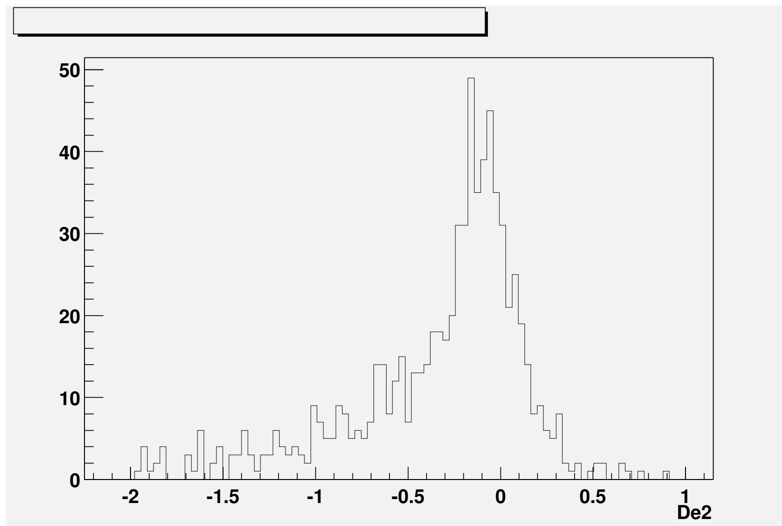

FIGURE 3.4. $\Delta E, B \to l\nu\gamma$

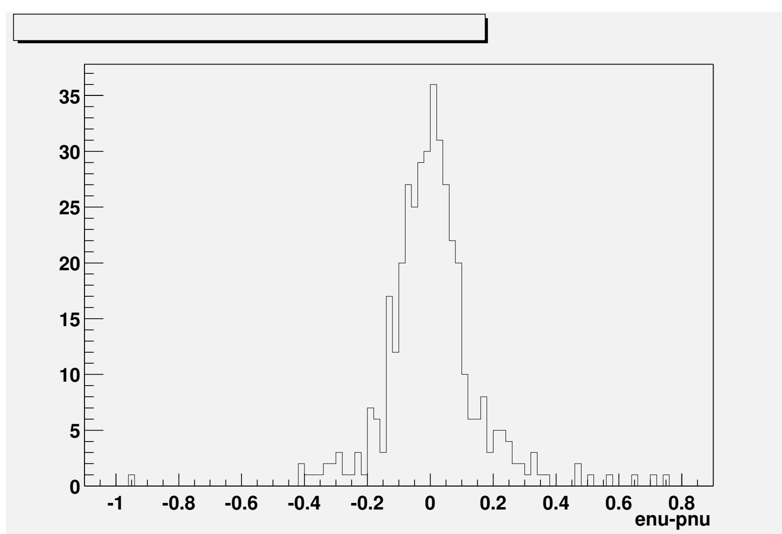

FIGURE 3.5. $E - p$, $B \to l\nu\gamma$

MC	Efficiency:Perfect	Eff:20%/$\sqrt{E}$	Eff:50%/$\sqrt{E}$
$B^0\overline{B^0}$	$(35.2 \pm 2.6)\%$	$(45.7 \pm 2.4)\%$	$(46.8 \pm 2.2)\%$
B^+B^-	$(89.8 \pm 0.3)\%$	$(93.6 \pm 0.3)\%$	$(93.9 \pm 0.4)\%$
$c\overline{c}$	$(89.81 \pm 0.7)\%$	$(92.8 \pm 0.7)\%$	$(93.70 \pm 0.7)\%$
$u\overline{u}/d\overline{d}/s\overline{s}$	$(88.7 \pm 1.0)\%$	$(91.5 \pm 1.1)\%$	$(91.8 \pm 1.1)\%$
Signal	$(92.8 \pm 1.3)\%$	$(95.4 \pm 1.3)\%$	$(97.0 \pm 1.3)\%$

TABLE 3. Efficiency of Veto for $l\nu\gamma$(after all other cuts)

4. Conclusions

It appears that using instrumentation within the B1 magnet could be a very effective means of rejecting background in certain specific situations: when the analysis is of the "whole event" type shown here, and significant background comes from Bs that have lost a single track. The investigation is continuing, including an attempt to study the effects of the veto on the SemiExclusive V_{ub} analysis.

References

[1] BAD# 345
[2] CLEO 96/1422