# Partial reconstruction of the $B^- \to \Lambda_c \overline{p} e^- \overline{\nu}_e$ decay

**Xin Zhao**

**The University of Kansas**

**(*CLEO Collaboration*)**

**APS April Meeting 2000, Long Beach, CA**

**April 30, 2000**

- Introduction
- Partial Reconstruction (technique)
- Sensitivity Study
- Future Plans

# Introduction

1. Intention
   - There are some uncertainties in B$\rightarrow$baryon decays.
   - It's known that the semileptonic branching ratio for B mesons obtained from experiment is lower than theoretical predictions.
   - The semileptonic decays of B mesons to charmed baryons can provide vital information on baryon production in B decays.

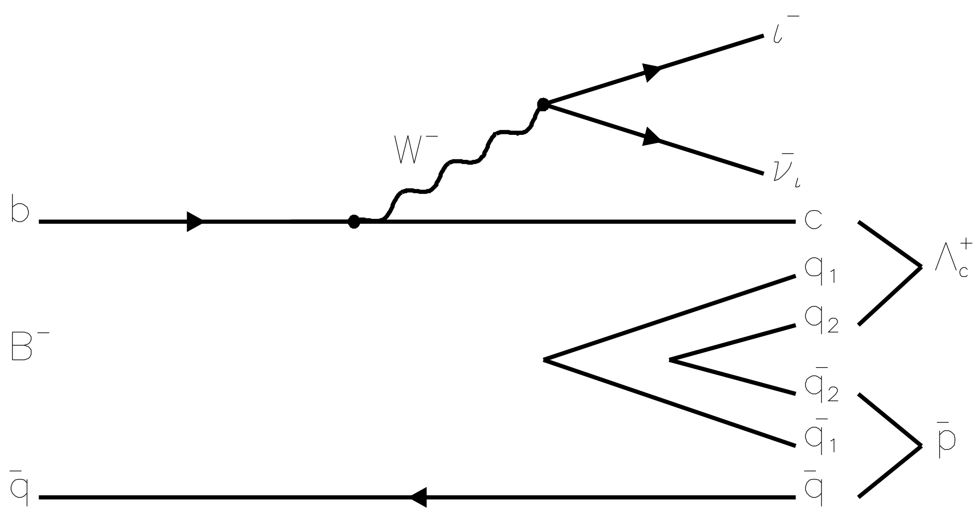
2. The current results
   - Previous CLEOII result is:

$$\frac{B(B^- \rightarrow \Lambda_c \overline{p} e^- \overline{\nu}_e\ )}{B(\overline{B} \rightarrow \Lambda_c^+ \overline{p}\ X)} < 0.04 \quad \text{(CL=90\%)}$$

   ( using a full reconstruction with $\Lambda_c^+ \rightarrow \pi^+ k^-$ p)

   - PDG98 gives:

$$B(B \rightarrow \Lambda_c^- p e^+ \nu_e) < 1.5 \times 10^{-3} \quad \text{(CL=90\%)}$$




*Feynman diagram of* $B^- \rightarrow \Lambda_c \overline{p} \ell^- \overline{\nu}_\ell$

3. Our new effort

$$\left.\begin{array}{l} CLEOII + CLEOII.V \\ \\ Partial\ Reconstruction \\ (p - e\ correlations) \end{array}\right\} \longrightarrow \left\{\begin{array}{l} higher\ statistics\ ? \\ more\ accurate\ B.R.\ \ ?? \end{array}\right.$$

☞ We are actually looking for all the $B \rightarrow X\overline{p}e^-\overline{\nu}_e$ decays, although the $\Lambda_c$ probably dominates the charmed baryon production.

☞ We are not using muons because they are only identified well above 1.4GeV/c in momentum and that is where the signal distribution is cutting off.

# Partial Reconstruction(technique)

1. **The angular distribution of signal e/$\overline{p}$ combinations (Figure 1)**
   Because of angular correlations, the angular distribution of the signal electron and anti-proton is not flat, but sloped. We will fit the angular distribution to get the number of signal events.

2. **Sources of Background(Figure 1)**
   (Here the B$\overline{B}$ MC and Continuum data are used to figure out the angular distribution of the background.)
   - e/$\overline{p}$ from opposite B mesons
     The e/$\overline{p}$ angular distribution of this background is flat because of no angular correlation.
   - e/$\overline{p}$ from same B meson but *NOT* signal
     This background is composed of "non-prompt" e/$\overline{p}$ combinations, beam-gas and other detector interaction background events, its shape is *sloped*.
   - continuum background
     We will subtract it using continuum data scaled by the appropriate luminosity and energy factors.
   - fake e/$\overline{p}$ background
     We expect it to be flat if the particles are from different B mesons. We will subtract this background using knowledge of the misidentification efficiencies.

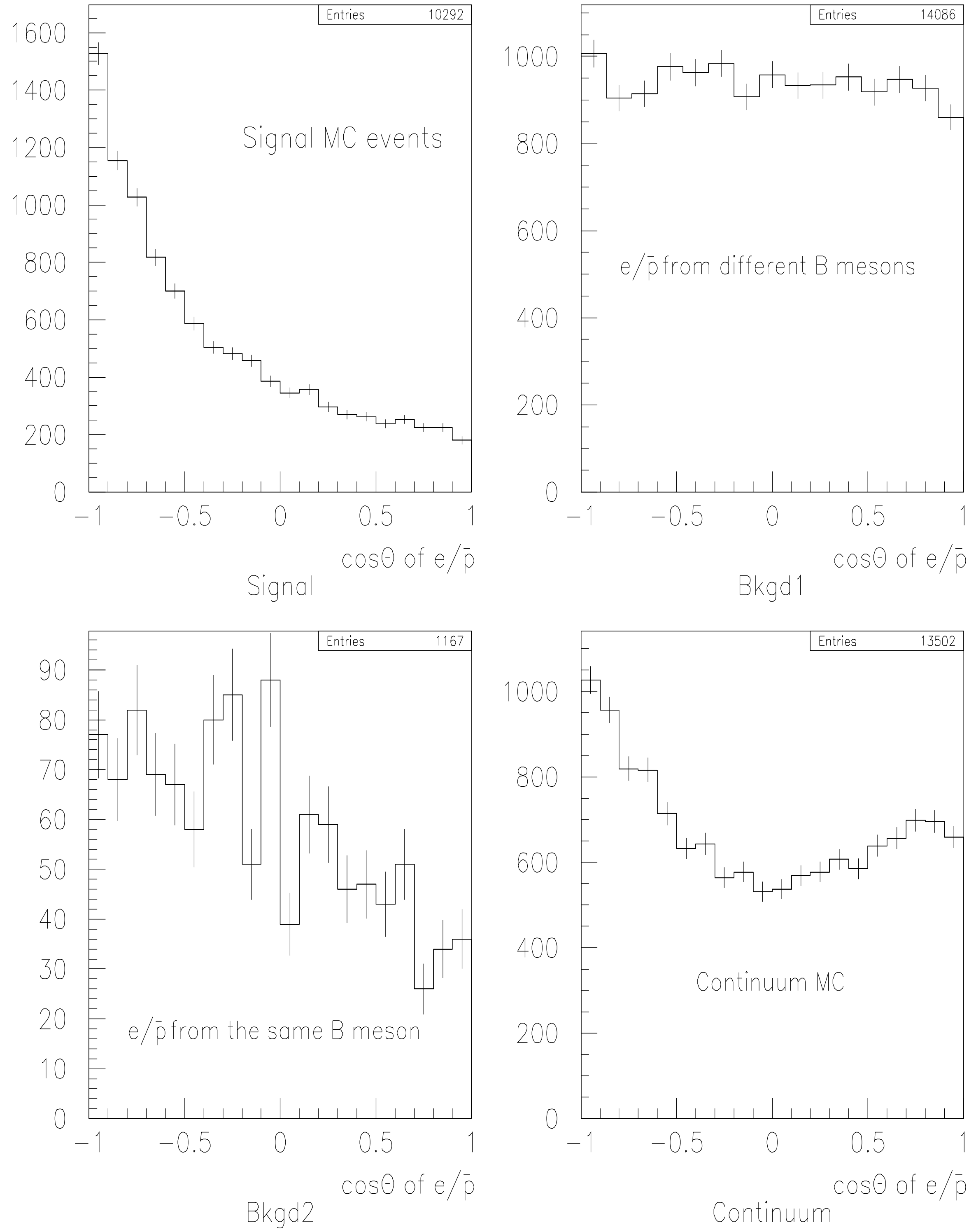



Figure 1: e/$\overline{p}$ angular correlations before $|\vec{P}_p| + |\vec{P}_e|$ cut

## 3. e/$\overline{p}$ particle identification and vertex cuts

- Charged tracks(electrons and anti-protons) must be well measured and originate at the IP.
- Electrons are identified using $dE/dx$ information and the ratio $E/p$, where $E$ is the calorimeter energy and $p$ is the momentum measured in the drift chamber.
- Anti-protons are identified using $dE/dx$ and TOF information, by requiring $\overline{p}$ consistency within 3 $\sigma$ and $\pi$ and $K$ vetos of greater than 2 $\sigma$
- Based on the MC study, the momentum of electrons, $P_e$, is 0.6$\leq P_e < 1.5$GeV/c, and the momentum of antiprotons, $P_p$, is in the range $0.2 \leq P_p < 1.5$GeV/c
- e/$\overline{p}$ have common vertex: vertex fit $\chi^2 < 10$ (95% C.L.) This cut can significantly suppress the backgrounds from the same B mesons.

4. **Exploit e/$\overline{p}$ angular distribution correlation**

Total momentum cut: (Figure 2)

$$|\vec{P}_p| + |\vec{P}_e| > 1.85 GeV/c$$

- ☞ This cut allows us to fit the e/$\overline{p}$ angular distribution easily. Eventually we will fit the distribution of data to get the number of signal events.
- ☞ It makes it much more clear whether there is *ANY* of the type of signal we are looking for.
- ☞ It suppresses the background from the same B meson by more than 93% (Figure 3). With the vertex cut, this background becomes negligible, simplifying the fitting procedure as well as reducing the systematic error from the MC modeling. The systematic error introduced by this negligence is less than 3% .

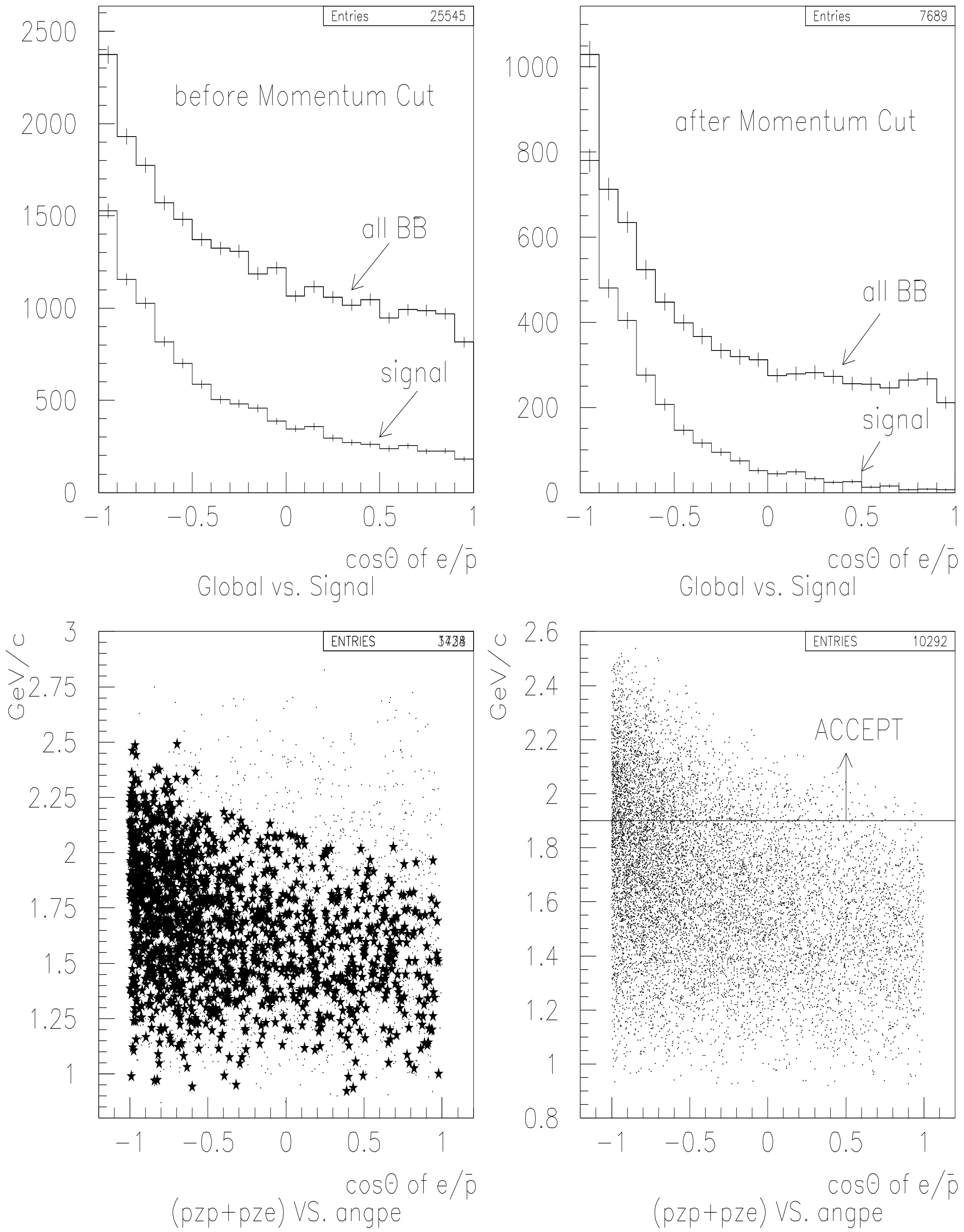



Figure 2: $|\vec{P}_p| + |\vec{P}_e|$ Selection plots

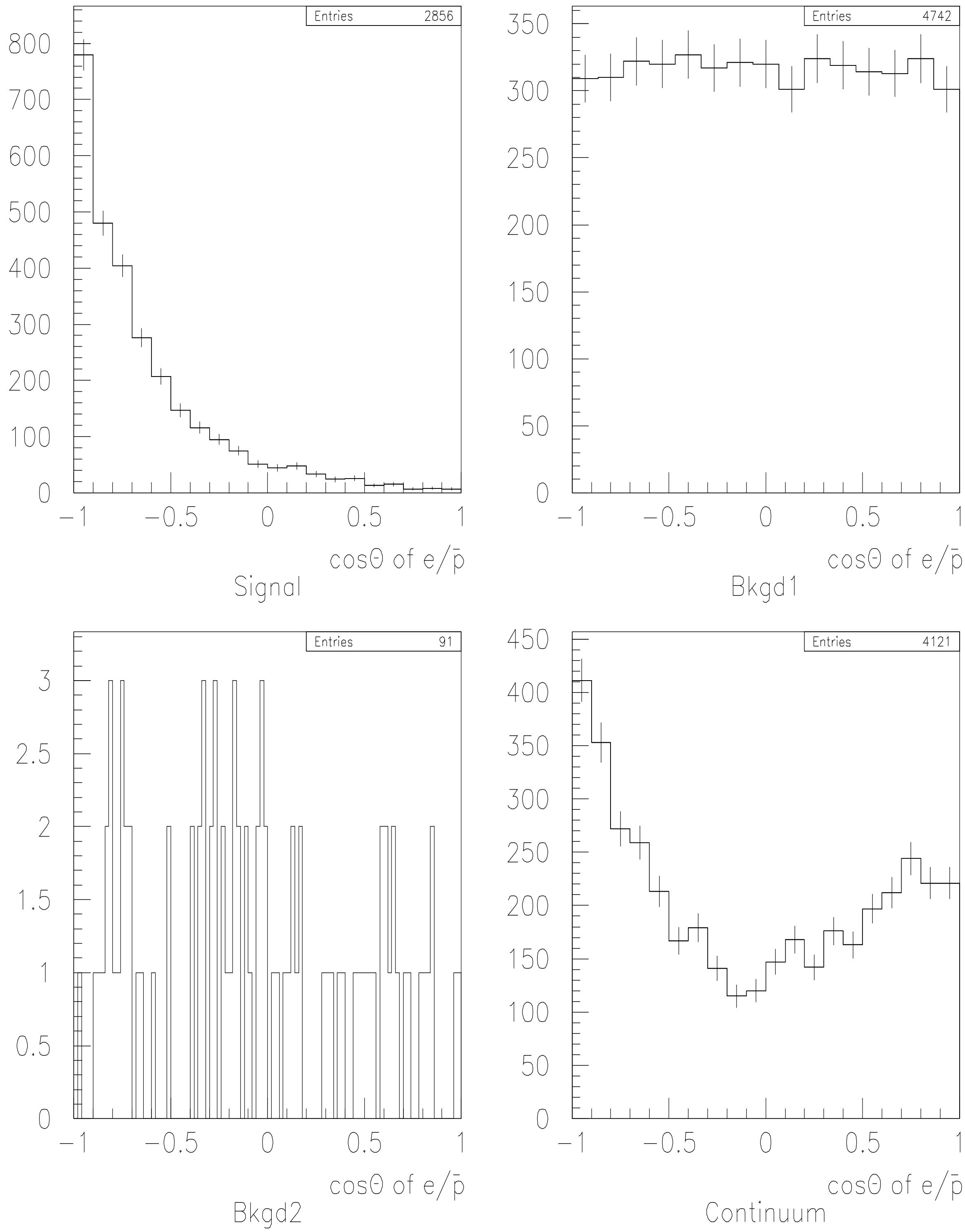



Figure 3: e/$\overline{p}$ angular correlation after $|\vec{P}_p| + |\vec{P}_e|$ cut

# Sensitivity Study

- From the MC study we obtain the following efficiencies.

| Event Type | Signal | Generic $B\overline{B}$ bkgd | Continuum bkgd |
|---|---|---|---|
| Efficiency | 7.7% | 0.07% | 0.02% |

The efficiency for signal events is obtained by using the tagged signal events, which is checked with an untagged small signal sample.

- Based on the CLEO's total data sample(9.66M $B\overline{B}$ events and 40M continuum events), we calculate the number of events in the entire cos(e$\overline{p}$) plot to get an estimate of what the sensitivity is.

| BR($B \to X\overline{p}e^-\overline{\nu}_e$) | Signal Events | Sensitivity ($\frac{S}{\sqrt{B}}$) |
|---|---|---|
| $1 \times 10^{-3}$ | 746 | 9.4 |
| $1 \times 10^{-4}$ | 75 | 1.0 |

We are expecting better sensitivity with a fit to the angular distribution plot.

# Future Plans

- Subtract fake electron and anti-proton backgrounds
- Study continuum data and check agreement with MC
- Optimise fit procedure
- Run through data
- In the future, we may slide down the 1.85$\mathrm{GeV}/c$ cut to gain more efficiency and then see if the signal emerges more strongly above background.