PAIR-SYMMETRIC BACKGROUND FOR SANE

P. Bosted April 19, 2005

- Pair-symmetric background large at low R'
- Sources:

  : $\pi^0 \rightarrow e^+e^-\gamma$ (about 50% of total, Branching Ratio is 1.2%, also known as Dalitz decay)

  : $\pi^0 \rightarrow \gamma\gamma$ (99% Branching Raio), $\gamma \rightarrow e^+e^-$ (about 1% probability in target, 1% in windows, etc.) (about 50% of total)

  : kaon decays ($< 0.5\%$ of total, using Lund Monte Carlo)

  : Wide-angle e^+e^- from photons in beam ($< 0.1\%$ for $\theta > 32$ degrees, from exact Mo-Tsai calculation).

VETO PAIR-SYMMETRIC EVENTS?

- Every pair-symmetric event has a lepton of opposite sign, so could veto events if both leptons detected.
- Opening angle m_e/E is very small, but target magnetic field spreads then vertically at colorimeter by about $50/P$ cm.
- Simulation made using same computer code that predicts e^+ yields within 50% for Hall B and C experiments (pi0.f, using Wiser fit to estimate π^0 yield, decays done using code from PYTHIA).
- Found that only 2% of events have both leptons hitting the calorimeter if origin is the target (for primary energy cluster with energy of 1 GeV). Not very useful.

- If photon converts to e^+e^- in OVC exit window, quartz hodoscope, or Cherenkov entrance window, then magnetic field deflects particles by about $2.5/P$ cm.
- Assuming need 12 cm between clusters to distinguish them, probability to observe 2nd cluster is sensitive function of minimum cluster energy that can be observed above background:

Threshold (GeV)	Probability
0.01	0.70
0.05	0.52
0.10	0.34
0.15	0.17

- Moderately useful. Can also veto events that don't have hits in all layers of hodoscope (if efficiency loss tolerable).
- Topology of clusters well-defined (always one above he other).

TAGGING PAIR-SYMMETRIC EVENTS WITH PHOTON

- Essentially all pair-symmetric events have a photon (other photon of π^0 decay).
- Probability of observing this photon in BigCal mainly depends on minimum threshold for distinguishing a cluster above threshold.
- For 1 GeV leptons, find:

Threshold (GeV)	Probability
0.05	0.21
0.10	0.19
0.15	0.16
0.20	0.13
0.30	0.09

- Somewhat useful. Reduces pair-symmetric background by about 20%, allows measurement of asymmetry of 20% of events.

PAIR-SYMMETRIC ASYMM FROM PI0 DETECTION

- Rate of $\pi^0 \to \gamma\gamma$ is about 50 times higher than pair-symmetric rate.
- If measure π^0 asymmetry versus momentum and angle, can easily calculate background lepton asymmetry versus momentum and angle.
- Typical opening angle between photons is m_π/P or about 6 degrees (35 cm at colorimeter). Good chance for both photons to fit within calorimeter size.
- Used simulation to get ratio of $\pi^0 \to \gamma\gamma$ events to 1 GeV single lepton events in BigCal. Assume minimum cluster separation of 12 cm. Results mainly sensitive to minimum cluster energy (threshold).

Threshold (GeV)	Ratio
0.2	70
0.3	50
0.4	20
0.5	10

- Even with 0.5 GeV threshold for second photon (well above energy from

most charged pions), get 10 times more statistics on primary π^0, which is plenty.

- Reconstructing the $\gamma\gamma$ invariant mass will eliminate most background
- Will need to trigger on BigCal only (no Cherenkov). Assuming clusters are separated in trigger (only higher energy photon contributes to trigger energy), then calculate rate as a function of energy threshold. Turns out that charged pions making hadronic shower cause more triggers than the γs from π^0s.

E_{min}	Rate π^0	Rate $\pi^\pm$	Rate total
0.2	100 kHz	25 kHz	125 kHz
0.3	17 kHz	7 kHz	23 kHz
0.4	4 kHz	2 kHz	6 kHz
0.5	1.6 kHz	650 Hz	2.2 kHz
0.6	700 Hz	300 Hz	1 kHz
0.7	400 Hz	200 Hz	600 Hz

- With a trigger threshold of 0.7 GeV or higher, the trigger rate should be quite tolerable, and we still get more π^0 than we need.

SUMMARY

- Can't do much to reduce pair symmetric background or measure it's asymmetry by detecting second lepton or the extra photon from the π^0 decay
- But we can measure π^0 asymmetry with very high statistical accuracy and use to get pair-symmetric asymmetry with error smaller than for the DIS electrons, so introduces negligible systematic error.
- Can do this with 0.7 GeV energy threshold on BigCal trigger and have < 1 kHz trigger rates.