SANE
Pair-symmetric Background

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Pair-Symmetric Background

- Target backgrounds
  - Processes that compete with or imitate inclusive inelastic (e,e') scattering
  - Three main sources
    - Bethe-Heitler (bremsstrahlung) into e^+e^-: very small angle with respect to beam $\sim m_e/E$; not a concern for SANE. Møller not important, either.
    - π^0 decays: $\pi^0 \to \gamma e^+e^-$ (1.2%) and $\pi^0 \to \gamma\gamma$ (99%): SANE's main concern
    - π misidentified as e: contamination
  - Other particle decays into e^+e^- or e^- : small probablity, will neglect.
- Forward tracker will be able to distinguish charge signs for $p \leq 1$ GeV/c

Effect of Target Background on Asymmetry Measurement

- Target background for SANE is mostly e^+e^- pairs: BETA is charge sign insensitive, detects both.
- The measured electron asymmetry A_m must be corrected for the counts N_b and possible asymmetry A_b coming from the target background
- Need to estimate or measure both the background rate and asymmetry
- Estimate background from previous measurements
- Measure positron rates in charge sign sensitive HMS

$$N_m = L_m + R_m = N + N_b$$

$$A_m = \frac{(L-R)+(L_b-R_b)}{N_m} = \frac{(N_m-N_b)A+N_bA_b}{N_m}$$

$$A = \frac{A_m - f_b A_b}{1-f_b}; \qquad f_b = \frac{N_b}{N_m}$$

$$\delta A^2 = \frac{1}{(N_m-N_b)^2}\Big[(N_m\delta A_m)^2+(N_b\delta A_b)^2 + \left(\frac{A_m-A_b}{N_m-N_b}\right)^2\left((N_m\delta N_b)^2+(N_b\delta N_m)^2\right)\Big]$$

$$= \frac{1}{(1-f_b)^2}\left[(\delta A_m)^2+(f_b\delta A_b)^2+\left(\frac{A_m-A_b}{1-f_b}\right)^2(\delta f_b)^2\right]$$

π^0 Related Backgrounds

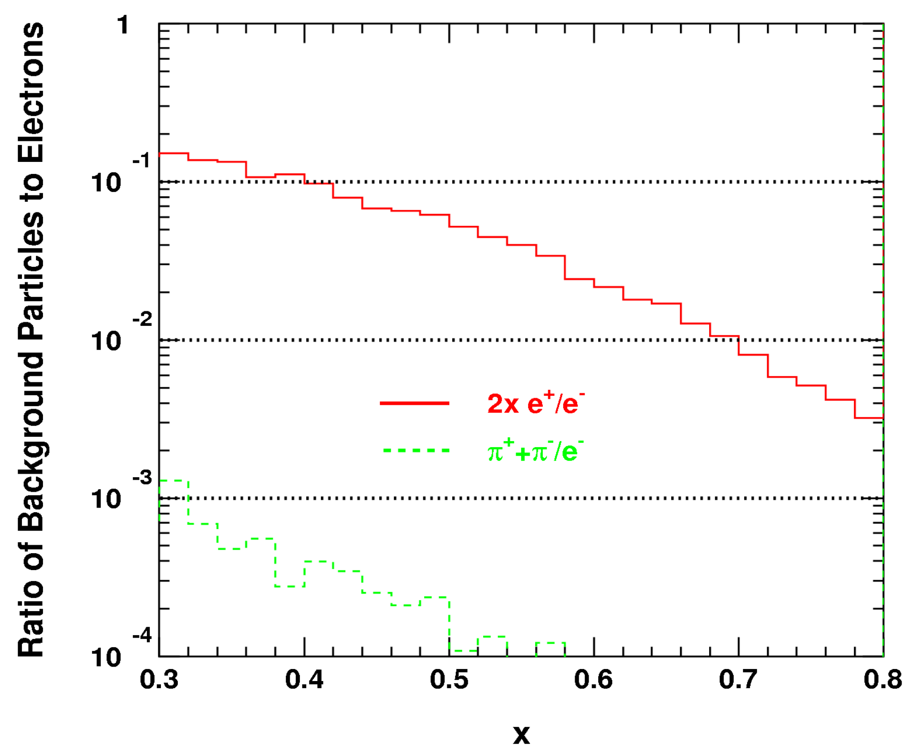
- π^0 Dalitz decay: $\pi^0 \rightarrow \gamma e^+ e^-$
  - 1.2% branching ratio
- $\pi^0 \rightarrow \gamma\gamma$
  - $\gamma \rightarrow e^+ e^-$
  - 99% branching ratio*X_0 radiation thickness from target to detector*2 γ's
  - SANE $<X_0>$= 0.028
- Effective Dalitz pairs >= 29% of π^0
  - (P. Bosted CLAS-Note 2004-005)

Material in front of BigCal*	g/cm²	X0
Target cell	0.689	0.016
Target windows	0.156	0.007
Cherenkov windows	0.076	0.002
Cherenkov gas	0.156	0.004
Sub Total	1.077	0.028

* Trigger Cherenkov*BigCal

Background Simulation in Proposal

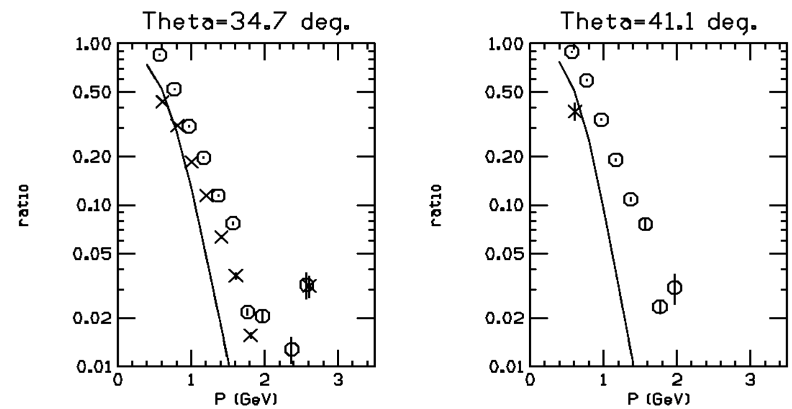
- Charge-symmetric processes from π^0 decays (simulated by G. Warren)
  - SLAC $e^+ e^-$ parameterization
- Reduce positron rates by increasing energy threshold to $E' > 1.3$ GeV
  - Lose some low x range at low Q^2
- Measure ratio of rates in HMS.
- Measure ratio of asymmetries using events with γ, $\gamma\gamma$ and $e^+ e^-$ in BETA
- Hadron backgrounds measured by ignoring Gas Cherenkov in trigger

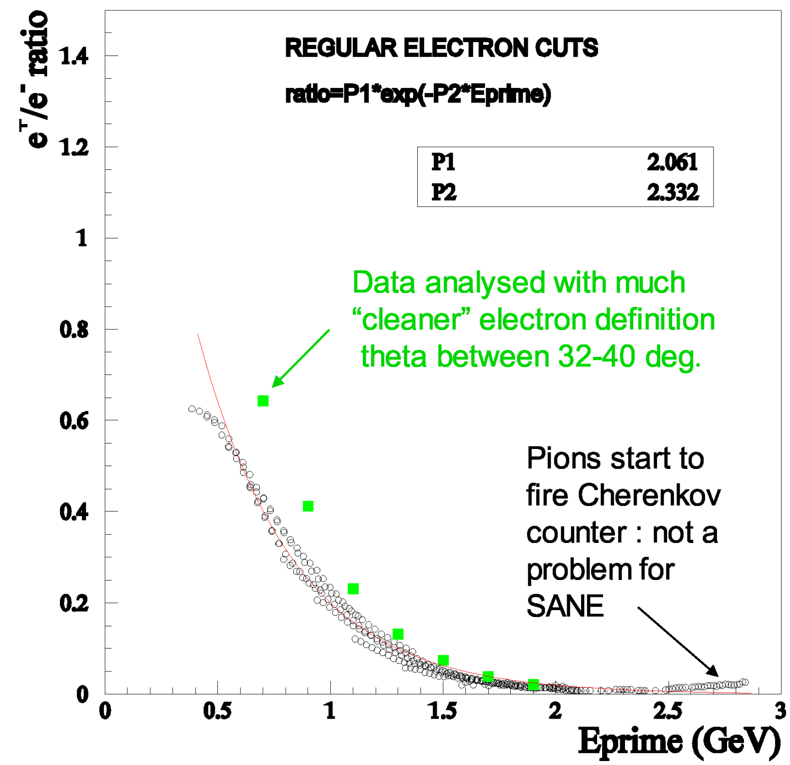


Parallel Configuration: Model with e^+/e^- Pairs in eg1b (I)

- Report by P. Bosted on e+e- and pion backgrounds
- Relevance for SANE:
  - 5.7 GeV data vs 6 GeV SANE
  - 34.7 ° and 41.1° vs 40 ° SANE
  - E' range 0 - 3.6 GeV
- CLAS data analyzed by V. Dharmawardarne
  - no angular dependence
  - good 2-parameter fit to ratio

$$f_{\mathrm{CLAS}}(E') = e_C^+/(e_C^- + e_C^+) = P_2 exp(-P_2 E')$$





Polarized Pairs in CLAS's and in Hall C

- Comparison of SANE and eg1b
  - very similar kinematics = similar π^0 production rates
- eg1b effective radiator:
  - $0.028\, X_0 = z_{CLAS}\,(7/9) X_0$ + Dalitz
- Hall C effective radiator (**HMS**):
  - $0.06\, X_0 = z_{HMS} (7/9)\, X_0$ + Dalitz
- $z_{HMS} = 3\, z_{CLAS}$, or $e^+_{HMS} = R_{H/C}\, e^+_{CLAS}$
- Solve $f_{CLAS}(E')$ for e^+_{CLAS}; $R_{H/C}$=0.06/0.028
  - $f_{HMS}(E') = R_{H/C} f_C / [1 + f_C(R_{H/C} - 1)]$
  - $f_{SANE}(E') = 2R_{H/C} f_C / [1 + f_C(2R_{H/C} - 1)]$

SANE e+/e- rates (SLAC parameterization)

E' = 1 GeV

θ	SANE e+	SANE e+/(e- + e+)	f_SANE(f_C)
36	1.23	0.55	0.52
40	0.58	0.37	0.52

E' = 1.35 GeV

θ	SANE e+	SANE e+/(e- + e+)	f_SANE(f_C)
36	0.49	0.33	0.29
40	0.17	0.14	0.29

(From Proposal Table 6)

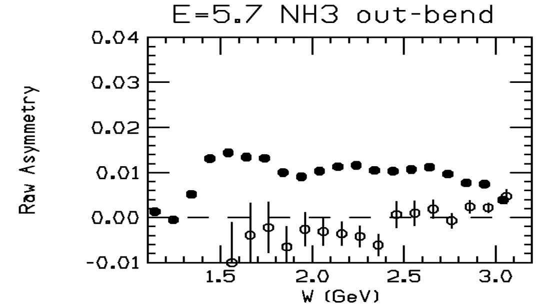
e^+/e^- Pairs in CLAS's eg1b (III)

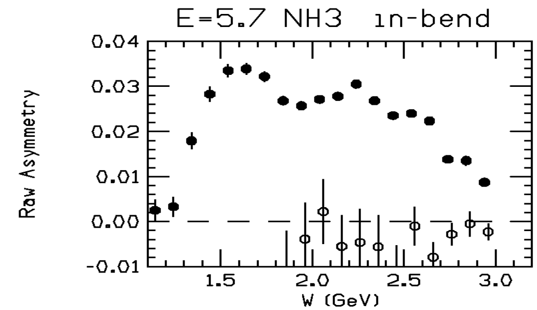
- SANE, eg1b cover same *W* range
- e+ asymmetry seems < ~20% of e-
- Uncertainty in asymmetry < ~ 100%
- Uncertainty in rate ratio ~ 30%
- Using SANE's e+/e- rates, eg1b's A_m
  - dilution size at low *x* confirms need for cut
  - moderate errors for d*f*/*f* = .3

$$A = \frac{A_m}{1 - f_b}; \qquad A_b \sim 0$$

$$\frac{\delta A^2}{A^2} = \left[\left(f_b \frac{\delta A_b}{A_m} \right)^2 + \frac{\delta f_b^2}{(1-f_b)^2} \right]$$

$$\frac{\delta A}{A} = \frac{f_b}{(1-f_b)} \left[\left(\frac{\delta A_b}{A} \right)^2 + \left(\frac{\delta f_b}{f_b} \right)^2 \right]^{1/2}$$





E' [GeV]	θ	x	f = Nb/Nm	df / f	A/Am	dA/A
1	36	0.24	0.552	0.3	2.23	0.44
	40	0.3	0.367	0.3	1.58	0.21
1.35	36	0.35	0.327	0.3	1.485	0.17
	40	0.42	0.143	0.3	1.167	0.06

(Using dAb/A=0.2, corresponding to dAb/Am=0.2/(1-