SANE
Update on Backgrounds

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(Version updated after meeting)

Backgrounds in SANE

- Two sources of background
  - Target
  - Beam Line
- 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: $\pi^0 \rightarrow \gamma e^+ e^-$ (1.2%) and $\pi^0 \rightarrow \gamma\gamma$ (99%): SANE's main concern
    - π misidentified as e: contamination
  - Other particle decays into $e^+ e^-$ or e^- : small probablity, will neglect.
- Beam line backgrounds
  - separate issue

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

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

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

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

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

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

π^0 Related Backgrounds

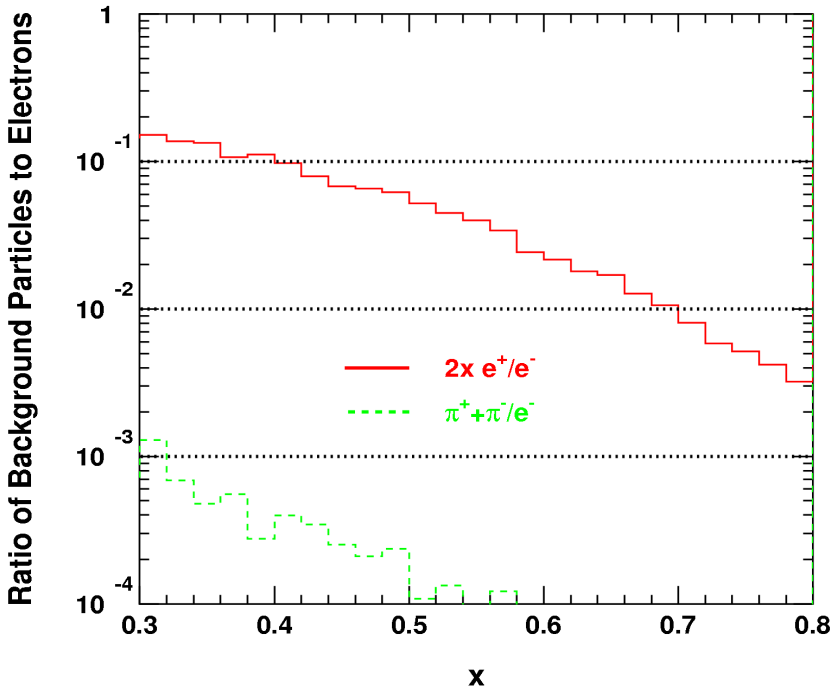
- π^0 Dalitz decay: $\pi^0 \rightarrow \gamma e^+ e^-$
  - 1.2% branching ratio
- $\pi^0 \rightarrow \gamma\gamma$
  - $\gamma \leftrightarrow e^+ e^-$
  - 99% branching ratio*X_0 radiation thickness from target to detector*2 γ's
  - SANE $<X_0>$ = 0.138
- Effective Dalitz pairs >= 29% of π^0
  - (P. 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
Lucite	4.425	0.109
Sub Total	5.502	0.138

Thickness yet to be defined
Cherenkov mirrors
BigCal front cover
Lucite gain monitor

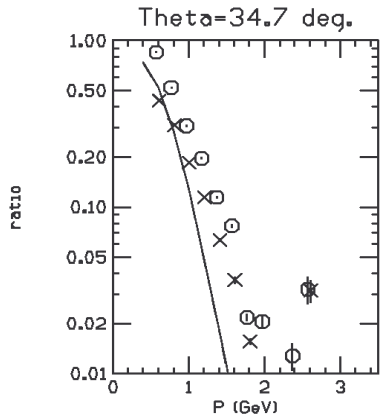
Background Simulation in Proposal

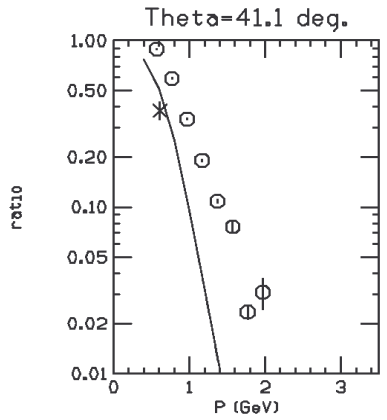
- Charge-symmetric processes from π^0 decays (simulated by G. Warren)
  - SLAC $e^+ e^-$ parameterization
- Reduce positron rates by increasing energy threshold to $E' > 1.3$ GeV
  - Lose some low x range at low Q^2
- Measure ratio of rates in HMS.
- Measure ratio of asymmetries using events with γ,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

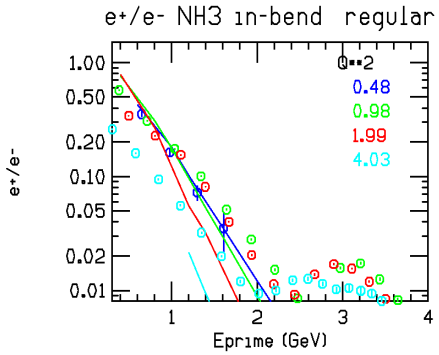


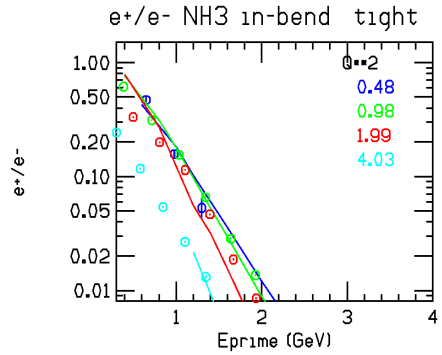
e^+/e^- Pairs in CLAS's eg1b (I)

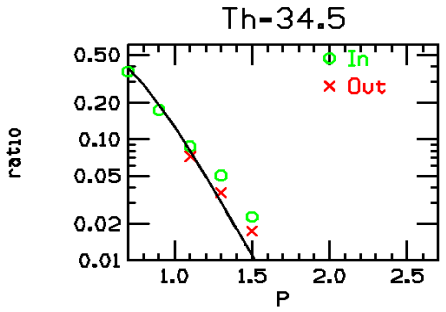
- Report by P. Bosted on e+e- and pion backgrounds
- Relevance for SANE:
  - 5.7 GeV data vs 6 GeV SANE
  - 34.7 ° and 41.1° vs 40 ° SANE
  - *E'* range 0 - 3.6 GeV
- π^0 decay photons convert to e+e- with probability X_0 * 7/9
- Dalitz decays add a 0.006 probability (½ of branching ratio)
- Good model agreement with clean e+ data at lower *E'*











Clean e+

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

- Comparison of SANE and eg1b
  - very similar kinematics = similar π^0 production rates
- eg1b effective radiator:
  - $0.014\ X_0 = 0.008\ X_0 + ½$ Dalitz
- SANE effective radiator:
  - $0.144\ X_0 = 0.138\ X_0 + ½$ Dalitz
- SANE and eg1b*X_{0SANE}/X_{0eg1} seem to agree, but X_0 for SANE OK?
- e+ rates are substantial
  - main issue is e+ asymmetry

e+/e- rates

E' = 1 GeV

θ	eg1	SANE	eg1*SANE X0
36	0.13	1.23	1.3
40	0.1	0.58	1
44		0.26	

E' = 1.35 GeV

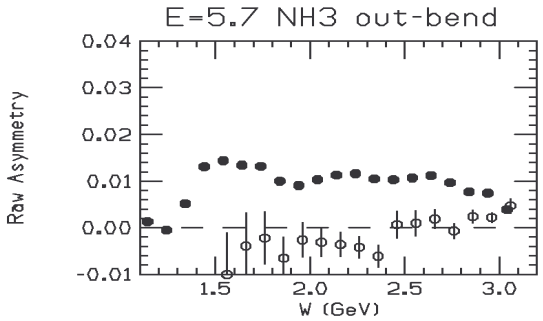
θ	eg1	SANE	eg1*SANE X0
36	0.02	0.485	0.2
40	0.01	0.167	0.1

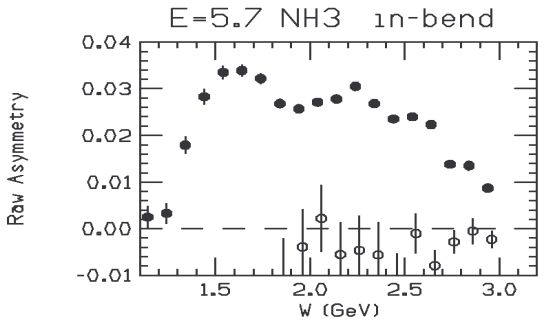
e^+/e^- Pairs in CLAS's eg1b (III)

- 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

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

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

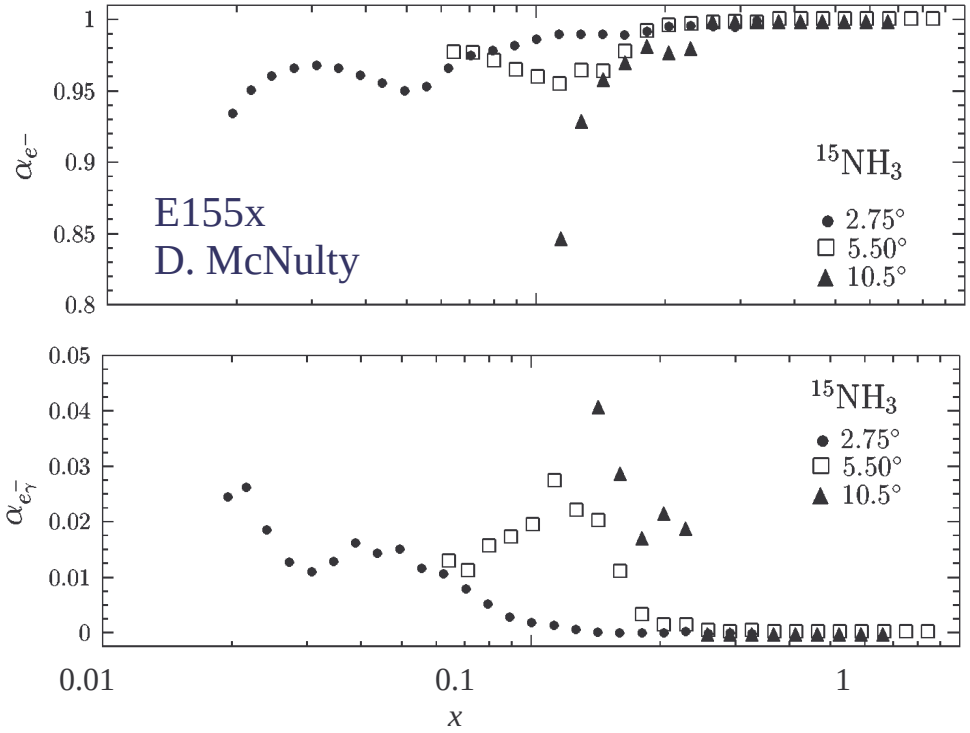




E' [GeV]	θ	*x*	f = Nb/Nm	df / f	A/Am	dA/A
1	36	0.24	0.545	0.3	1.96	0.19
	40	0.3	0.375	0.3	1.48	0.13
1.35	36	0.35	0.327	0.3	1.388	0.11
	40	0.42	0.143	0.3	1.134	0.05

SANE 80°

- For SANE 80°
  - e+/e- rates same as for 0°(?)
    - E155x $E' > 9$ GeV
    - e+/e- < ~ 0.02
  - A_b/A_m ratio:
    - E155x set $A_{e+} = 0$ (low statistics)
  - further study needed



Summary

- Preliminary comparison of SANE simulation to CLAS results on pair-symmetric backgrounds agree within 50%-100%
- More detailed comparisons should be helpful
- Background impact on asymmetry can be controlled with $E' > 1.3$ GeV cut
  - price is loss of low x range
- ~~Lucite seems important source of positron conversions~~
  - ~~need to optimize thickness in terms of error contributions from background asymmetry vs background rate~~
- HMS rate measurements should be planned taking into account improved background estimates and 80° data needs
  - Proposal estimate is ~75 h at 6 GeV - parallel asymmetry
  - may need HMS data during 80° data for comparison with parallel