NLC - The Next Linear Collider Project

SUSY-$\tilde{\mu}^{\pm}/\tilde{e}^{\pm}$ Studies

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- Current

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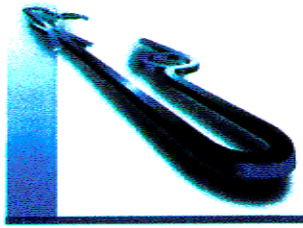
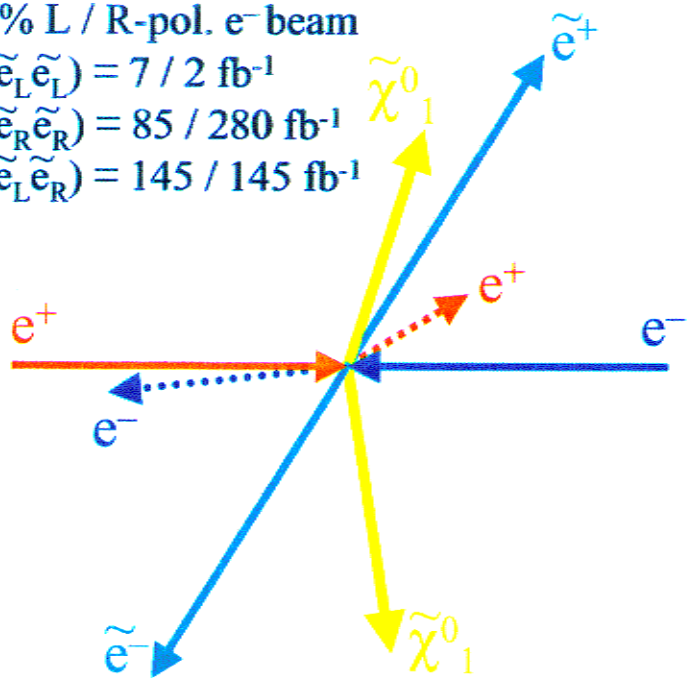


Outline

- Overview of Signal and Background
  - SIGNAL
    - SUSY parameter space
    - Cross sections
    - SUSY *vs.* SM signal
  - BACKGROUNDS
    - Z^0, $W^{\pm}$, $\gamma\gamma$
    - $\gamma^*\gamma^*$
- $\tilde{\mu}^{\pm}/\tilde{e}^{\pm}$ Analyses
  - Box method, $\mu^{\pm}/e^{\pm}$ differences
  - Background rejection
    - Čerenkov detector at $\theta \geq 20$ mrad
    - Kinematic parameters

Signal

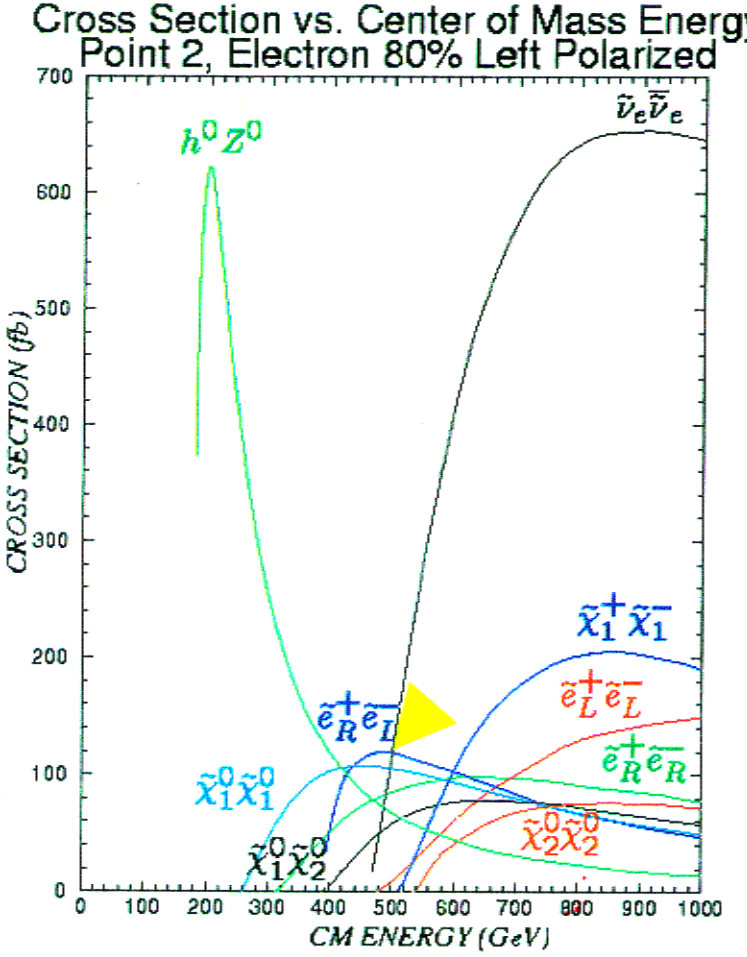
80% L / R-pol. e^- beam
$\sigma(\tilde{e}_L\tilde{e}_L) = 7 / 2$ fb^{-1}
$\sigma(\tilde{e}_R\tilde{e}_R) = 85 / 280$ fb^{-1}
$\sigma(\tilde{e}_L\tilde{e}_R) = 145 / 145$ fb^{-1}

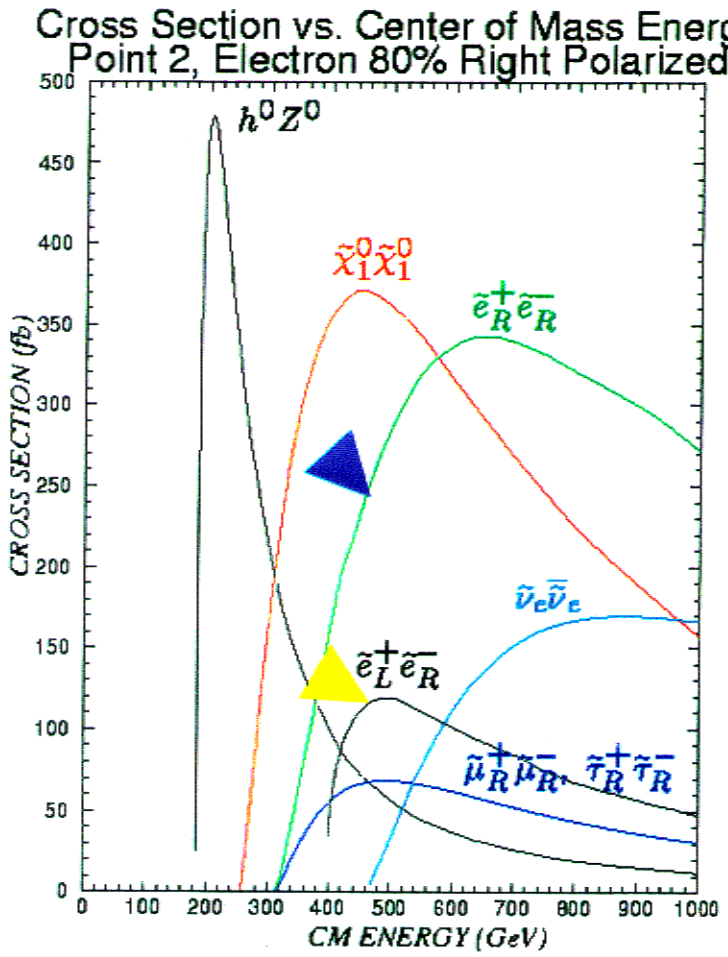


$e^+ e^- \rightarrow \tilde{e}^+ \tilde{e}^-$
$\tilde{e}^- \rightarrow \tilde{\chi}^0_1 e^-$
$\tilde{e}^+ \rightarrow \tilde{\chi}^0_1 e^+$

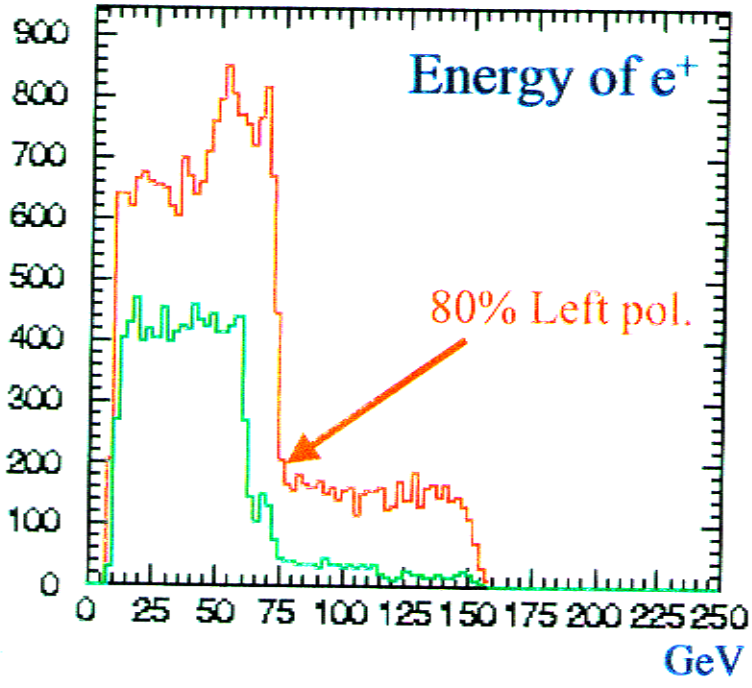
- "Point 2" in SUSY parameter space
  - parameters
    - $M_0 = 100$ GeV/c^2
    - $M_{1/2} = 300$ GeV/c^2
    - $\tan\beta = 2$
    - $A_0 = 0$
    - $\mu = -528$ (sgn $\mu = -1$)
  - masses
    - $\tilde{e}^{\pm}_L = 238$ GeV/c^2
    - $\tilde{e}^{\pm}_R = 157$ GeV/c^2
    - $\tilde{\chi}^0_1 = 128$ GeV/c^2
- Machine
  - $\sqrt{s} = 500$ GeV

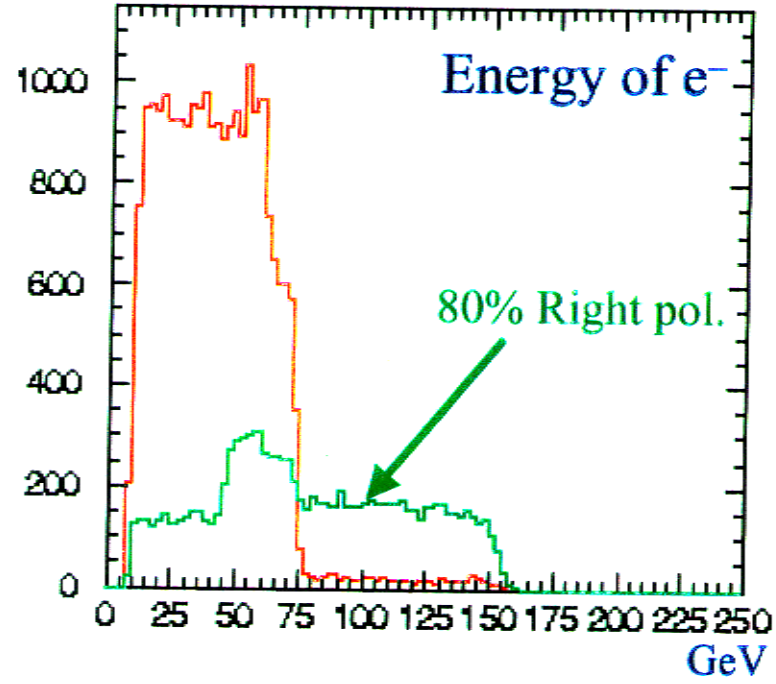
Cross-Sections





SUSY vs. SM





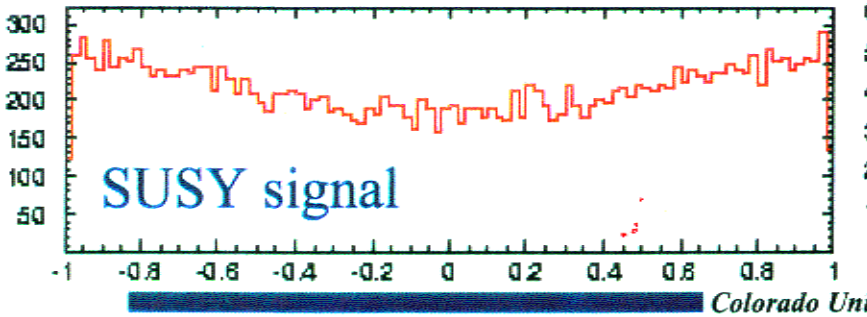
No SM signal has this type of behavior under L/R polarization change

Backgrounds

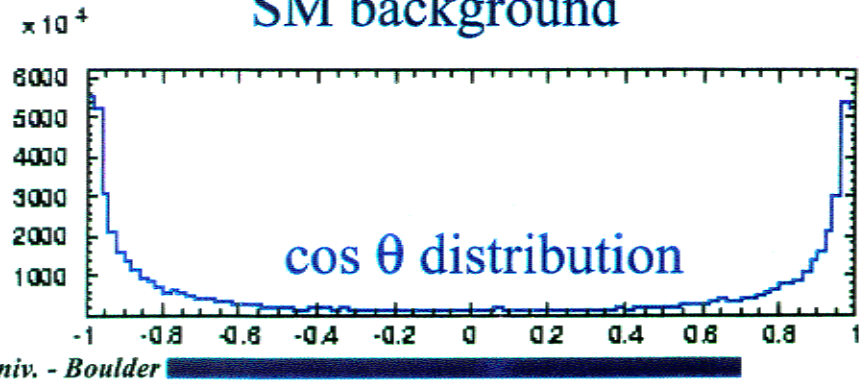
	80% Left pol.		80% Right pol.	
$\tilde{e}_L^+\tilde{e}_L^-$		2		7
$\tilde{e}_R^+\tilde{e}_R^-$		317		53
$\tilde{e}_L^\pm\tilde{e}_R^\mp$		146		145
W^+W^-		1461		12710
$\gamma+\gamma$		6840		6840
γ^* or Z^0		5380		5380
$\gamma+\gamma^*$ or Z^0		5200		5200
Z^0+Z^0		427		427
$\gamma^*\gamma^*$		4.42×10^7		4.42×10^7

W^+W^- background changes with pol.

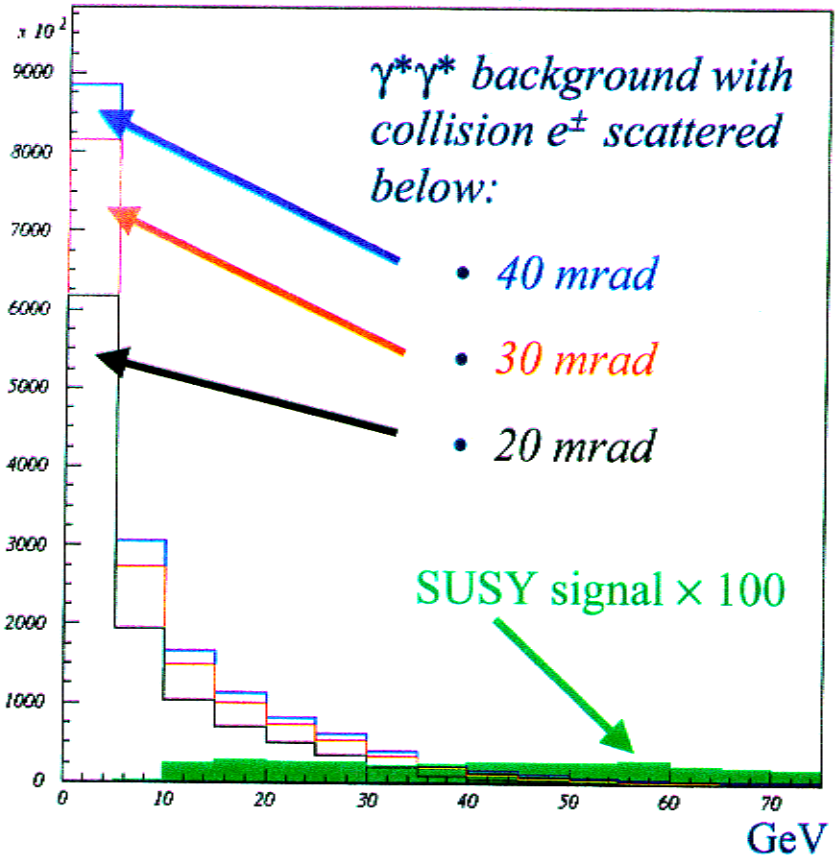
Angular distributions



SM background



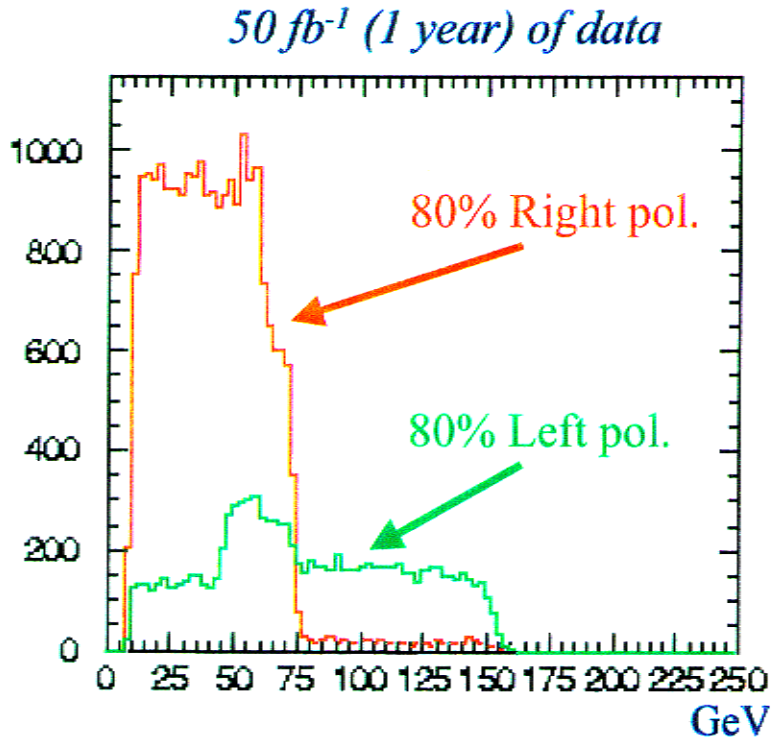
$\gamma^*\gamma^*$ BG



- $\gamma^*\gamma^*$ background
  - polarisation independent
  - dN/dE → huge, for E ≅ 0
  - over 3 orders in magnitude greater than SUSY signal

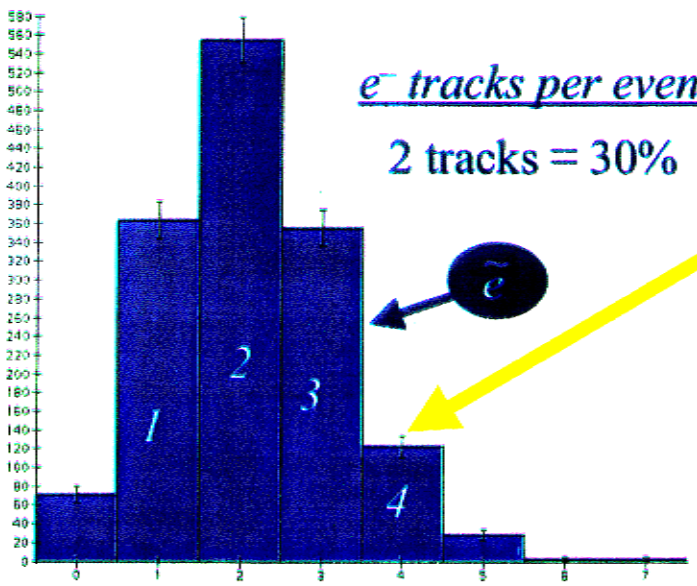
$\gamma^*\gamma^*$ background completely overwhelms SUSY signal

$\tilde{\mu}^{\pm}/\tilde{e}^{\pm}$ Analyses

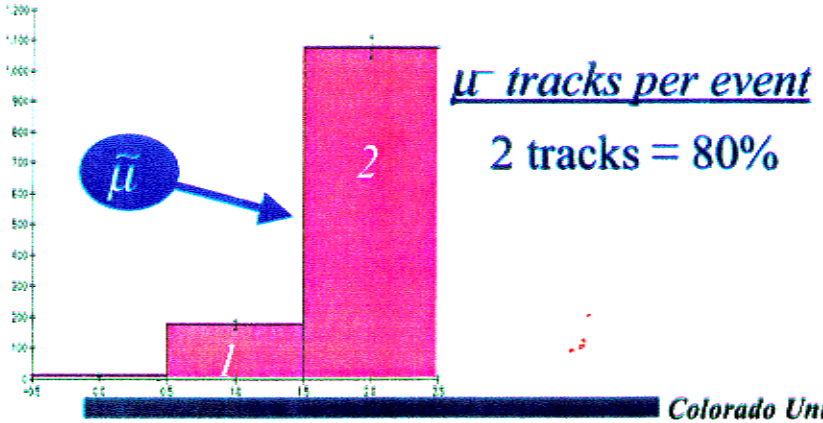


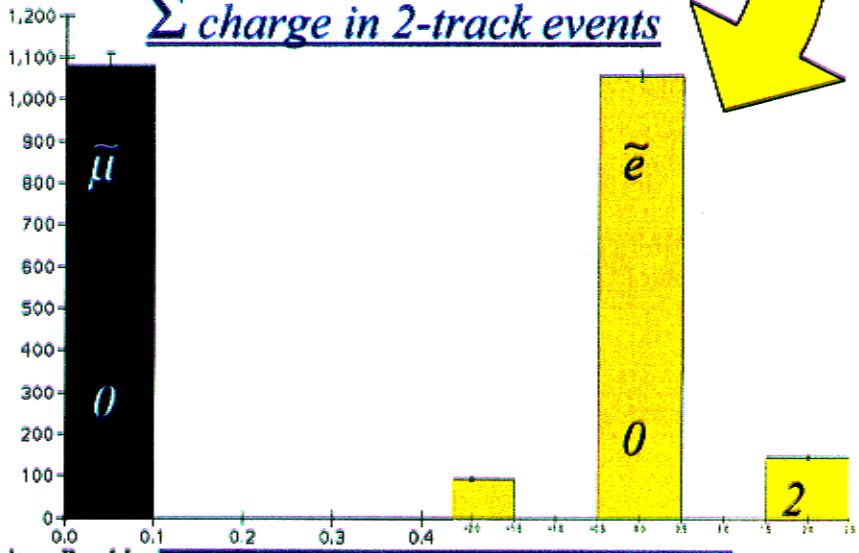
- Box E-distributions
  - overlay of different channel boxes
  - ***4 EDGES*** → mass of $\tilde{\chi}^0_1$ and $\tilde{e}^{\pm}_{L,R}$
    - polarisation changes reduce ambiguities
    - need accurate measurement
    - need BG reduction
- Other SUSY-space points
  - study decay of $\tilde{e}^{\pm}_{L,R}$ when $m_{\tilde{e}} \equiv m_{\tilde{\chi}}$ (*decay daughters at rest* in CM of decaying particle)
    - box reduced to a spike
    - cross-section low

$\tilde{\mu}^{\pm}/\tilde{e}^{\pm}$ Diff.'s

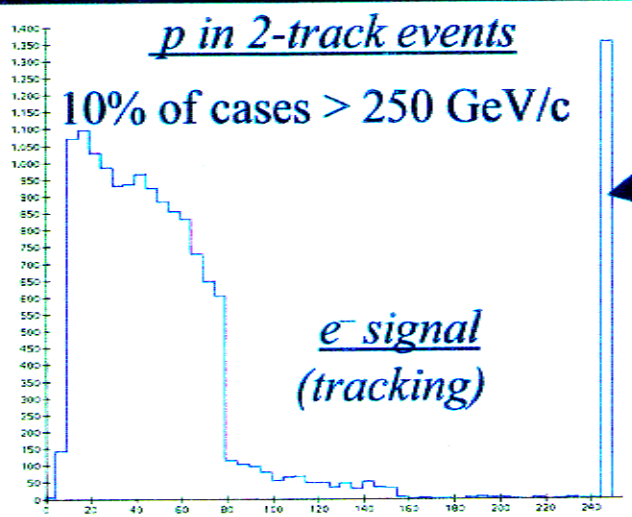


- e^- scattering
  - large nr. of events with 3-7 tracks
  - Σ charge in 2-trk events $\neq 0$

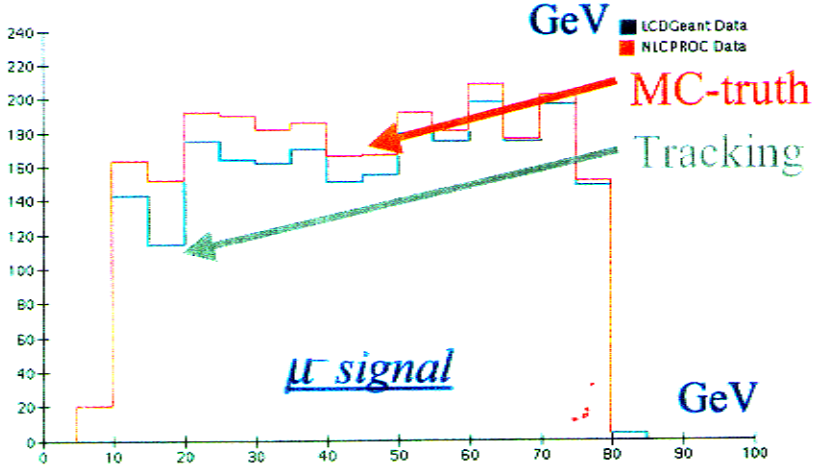


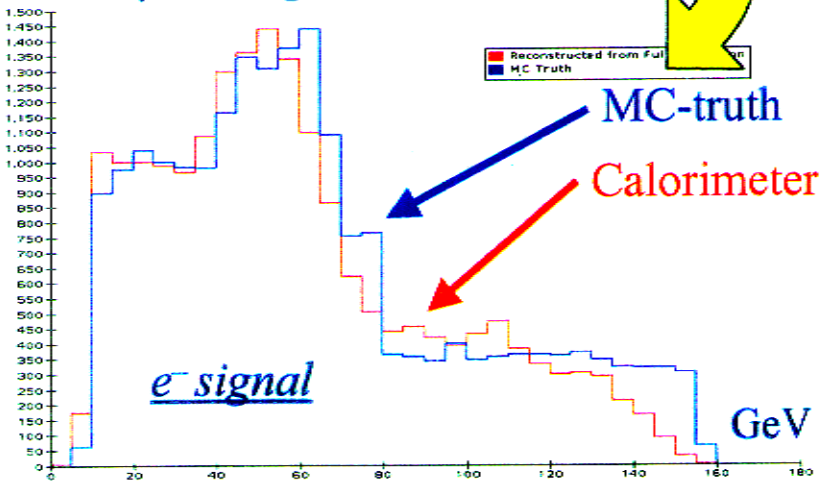


$\tilde{\mu}^{\pm}/\tilde{e}^{\pm}$ Diff.'s

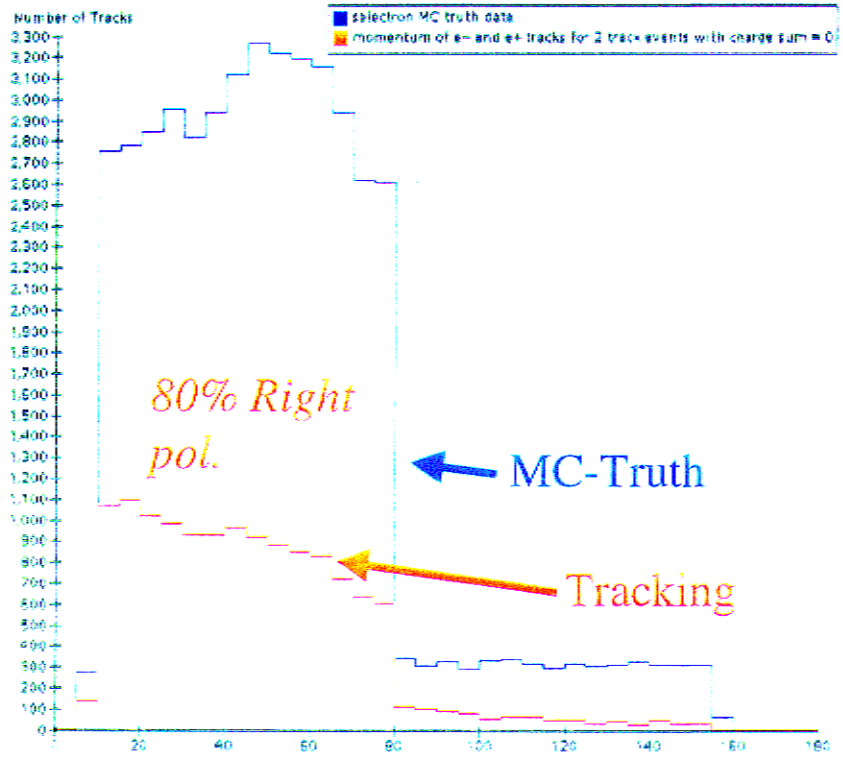


- e⁻ scattering
  - many tracks with p > 250 GeV/c
  - study beam-pipe materials
- CALORIMETER *vs.* MC-truth
  - drop-off at high energy for e⁻
  - μ⁻ as expected





$\tilde{\mu}^{\pm}$ / $\tilde{e}^{\pm}$ Diff.'s

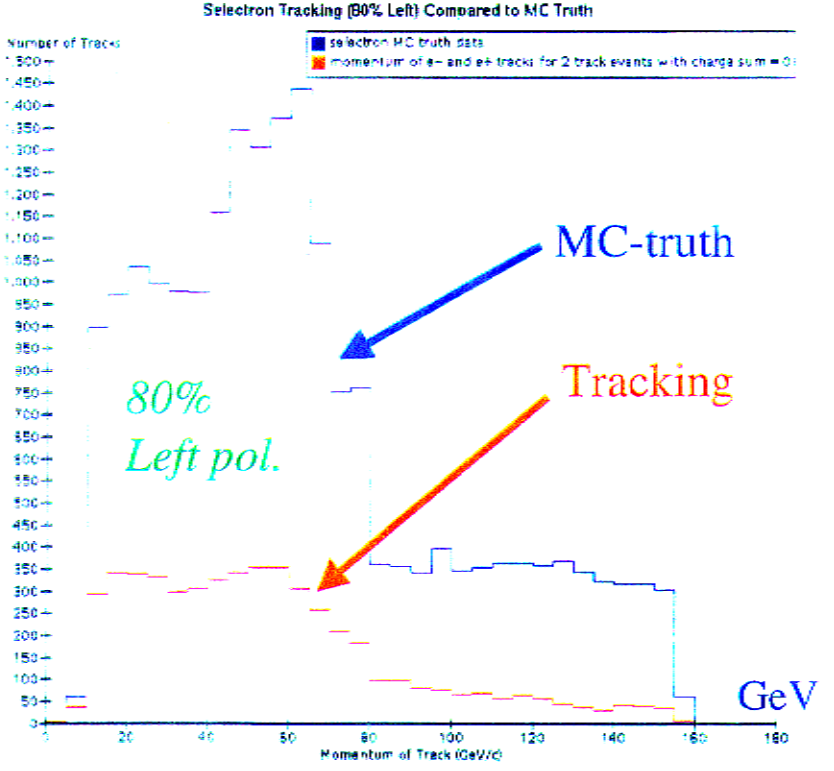


e−signal

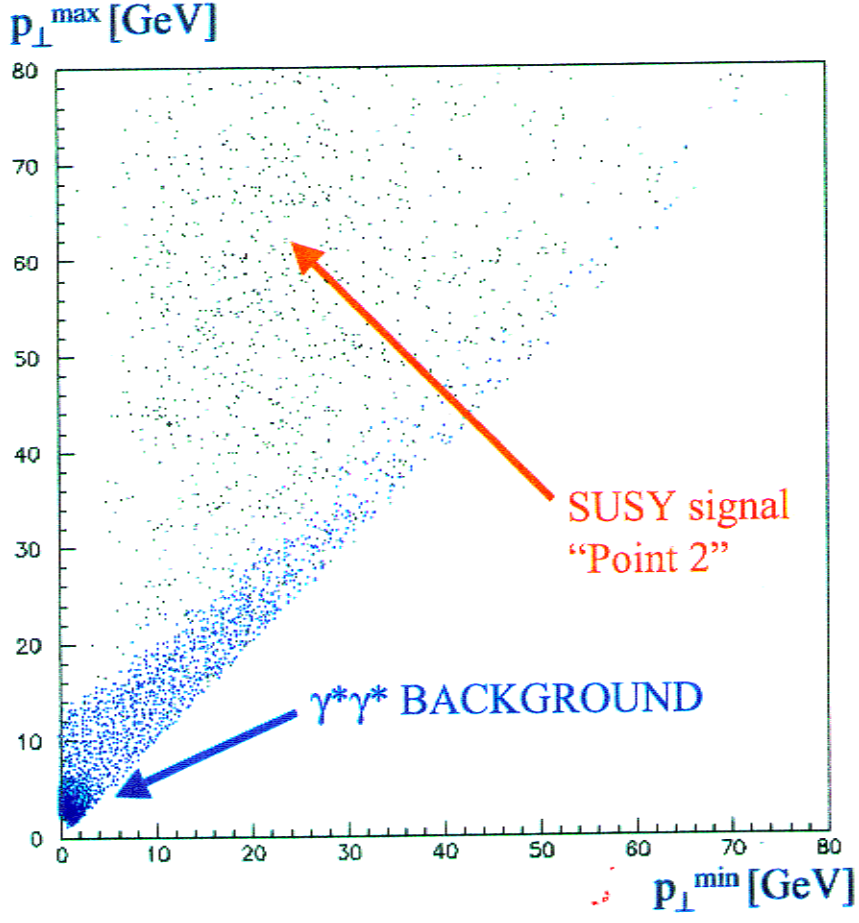
after 2 track events and Σ charge = 0

❑ Tracking *vs.* MC-Truth

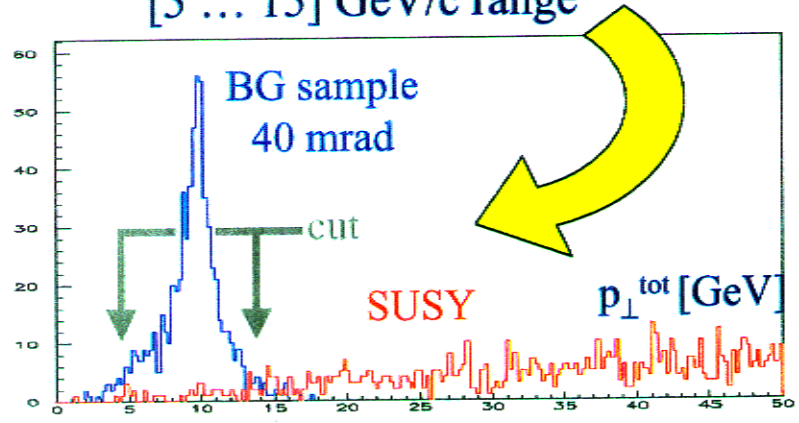
- efficiency problem for e^-



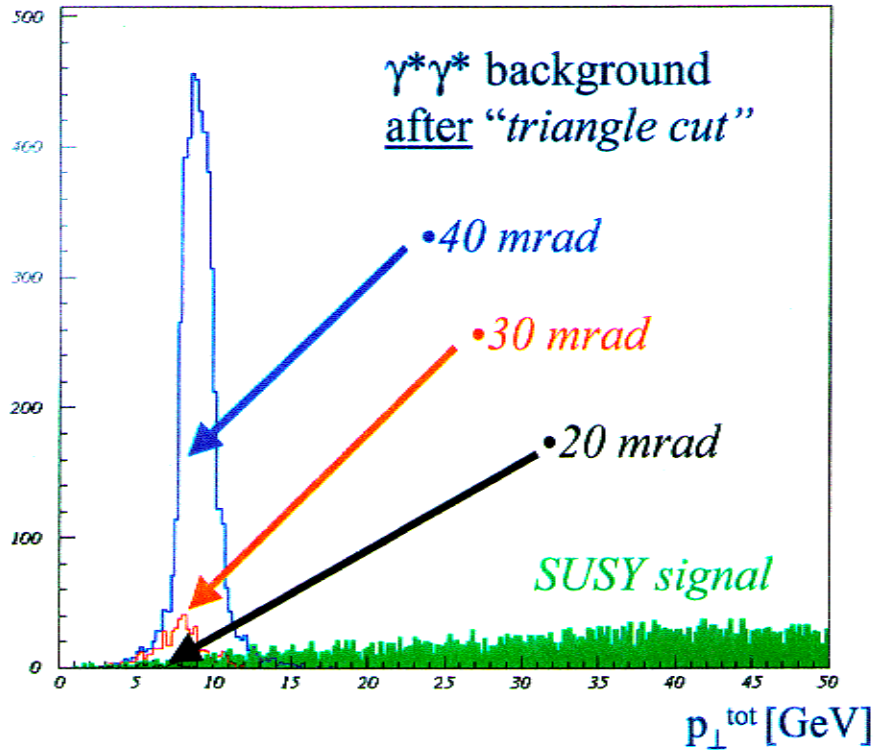
BG-kinematics



- $p_\perp^{min}$ - $p_\perp^{max}$ space density
  - γ*γ* background located within a triangle
    - $p_\perp^{max} < 8 + 0.84 p_\perp^{min}$
- residual γ*γ* BG
  - missing $p_\perp^{total}$ of event within [5 … 15] GeV/c range



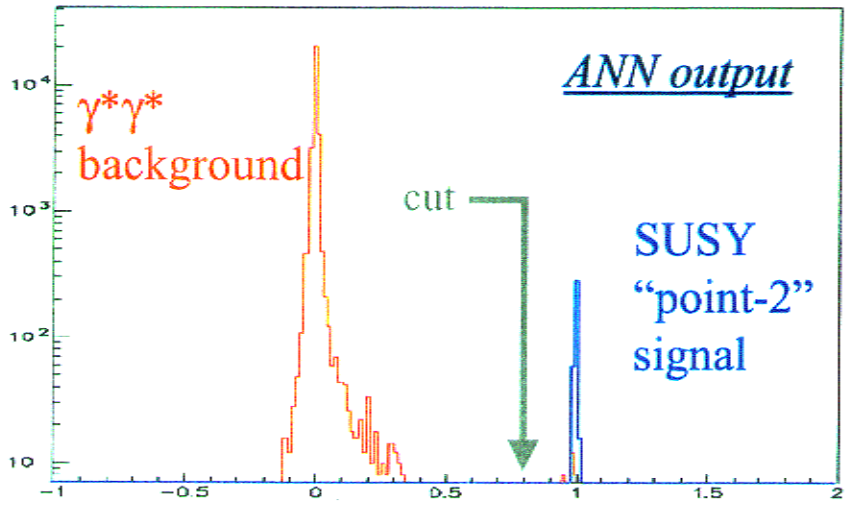
BG-rejection



Background decreases with $\theta_{acceptance}$ and ***shifts*** towards lower momentum

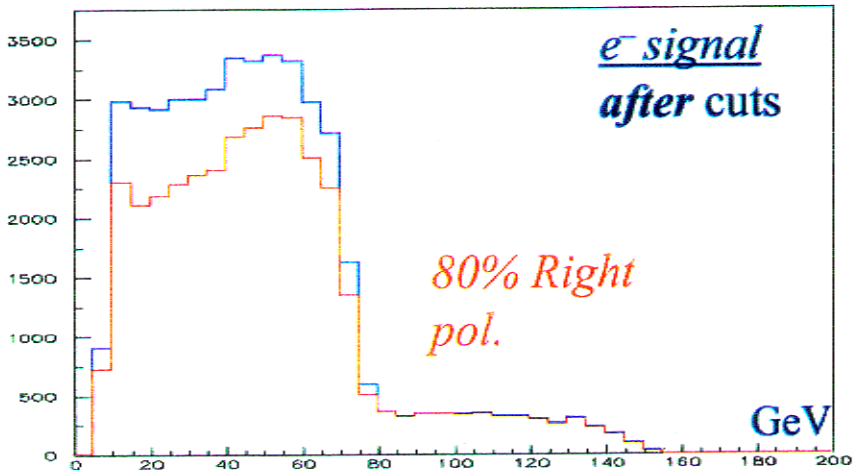
- ❑ ***Čerenkov Detector*** at 20-30 mrad
  - inside beampipe
  - at 150 cm from IP
  - detect ***at least one*** high energy $e^{\pm}$
- ❑ SUSY signal with $e^{-}_{L,R}$ with products at rest
  - signal concentrated in $p_{\perp}^{min\text{-}max}$ space under the γ*γ* background
  - can still use $p_{\perp}^{tot}$
  - Čerenkov Detector = ***essential !***

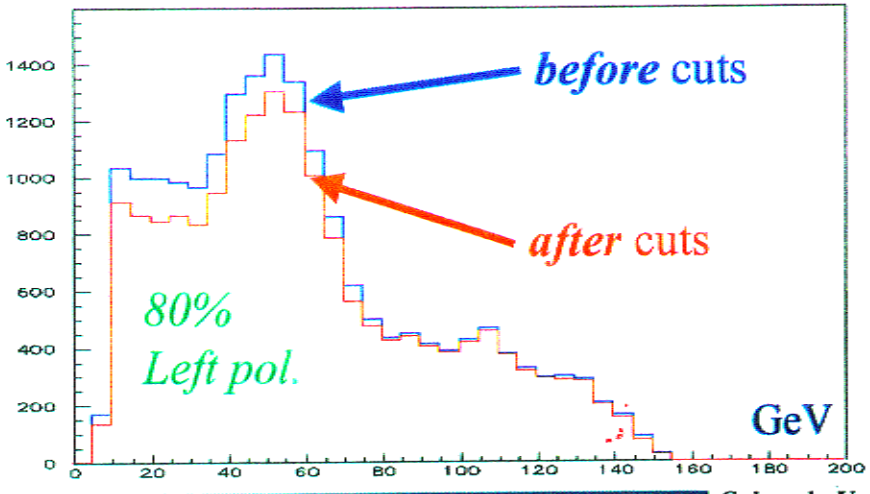
BG-rejection



- Artificial Neural Network (*ANN*)
  - use all features distinguishing SUSY signal from background
  - training
    - *training* and *control* samples for both signal and BG
    - overtraining
    - pruning
    - significant parameters
- ANN recognition of "Point" in SUSY-space
  - study feasability

Signal after Cuts

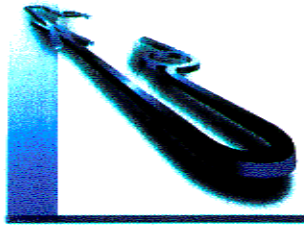




- Signal after "triangle" cut and $p_{\perp}^{tot}$ cut
  - efficiency for 80% ~~right~~ pol.
    - 81% - ***right*** polarisation
    - 91% - ***left*** polarisation
  - edges unchanged
  - for SUSY-space favorable points the 2 cuts are clean and accurate
- For unfavorable SUSY-space points Čerenkov Detector = *indispensable*

Conclusions

- ✓ good prospect for $\tilde{e}^{\pm}_{L,R} \rightarrow \tilde{\chi}^{0}_{1} + e^{\pm}$ analyses
- ✓ powerful BG-rejection in $p_{\perp}^{\text{min-max}}$ space
- ✓ Čerenkov Detector remains ***essential*** however
- ✓ in the process of understanding detector effects



Future Work

- ✓ better understanding of detector in $\tilde{e}^{\pm}_{L,R}$ analysis
- ✓ $\tilde{q}$ and $\tilde{\chi}^{\pm}_{1,2}$ analyses
- ✓ study ANN potential of yielding likelihoods of SUSY-"Points" for given signal