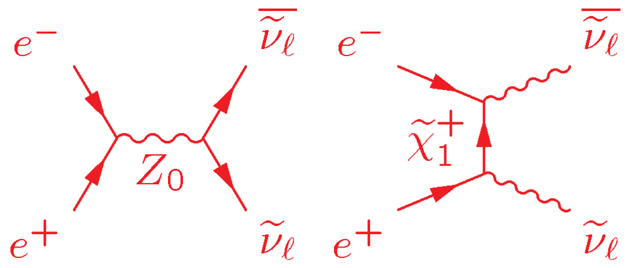
Mass Determination for the Sneutrino and Chargino

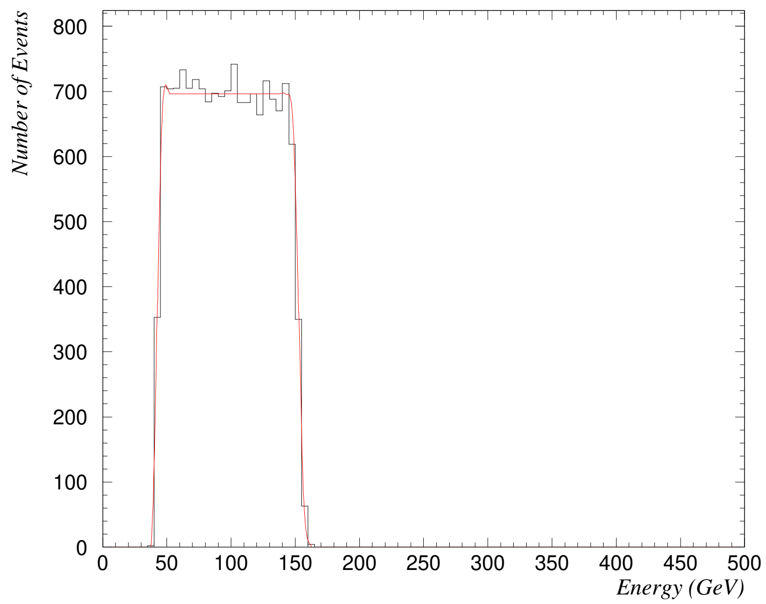
A study of Point 3 Sneutrino events at 500 GeV with 60% right polarized electrons.

The Signal

$$e^+e^- \to \tilde{\nu}_e\overline{\tilde{\nu}}_e \text{ where } \tilde{\nu}_e \to e^-\tilde{\chi}_1^+$$



Energy of visible electrons and positrons:



Supersymmetric Branching Ratios

$\widetilde{\nu}_e$ branching ratios

mode	fraction
$\widetilde{\chi}_1^+ e^-$	61.5%
$\widetilde{\chi}_2^0 \nu_e$	31.9%
$\widetilde{\chi}_1^0 \nu_e$	6.6%

$\widetilde{\chi}_1^+$ branching ratios

mode	fraction
$\widetilde{\chi}_1^0 q\overline{q}$	66.3%
$\widetilde{\chi}_1^0 \ell\nu_\ell$	33.7%

$\widetilde{\chi}_2^0$ branching ratios

mode	fraction
$\widetilde{\chi}_1^0 \ell^+\ell^-$	49.7%
$\widetilde{\chi}_1^0 q\overline{q}$	42.4%
$\widetilde{\chi}_1^0 \nu\overline{\nu}$	7.8%

$\widetilde{e}_R^-$ branching ratios

mode	fraction
$\widetilde{\chi}_1^0 e^-$	99.0%
$\widetilde{\chi}_2^0 e^-$	1.0%

Background

Process	Cross Section
$\tilde{e}^+\tilde{e}^-$	313
W^+W^-	2862
γ^*/Z_0	5383
$\gamma\gamma$	6844
$\gamma\gamma^*/Z_0$	5203
Z_0Z_0	4226

- The main supersymmetric background is $e^+e^- \rightarrow \tilde{e}^+\tilde{e}^-$ since $\tilde{e}^- \rightarrow \tilde{\chi}_1^0 e^-$.

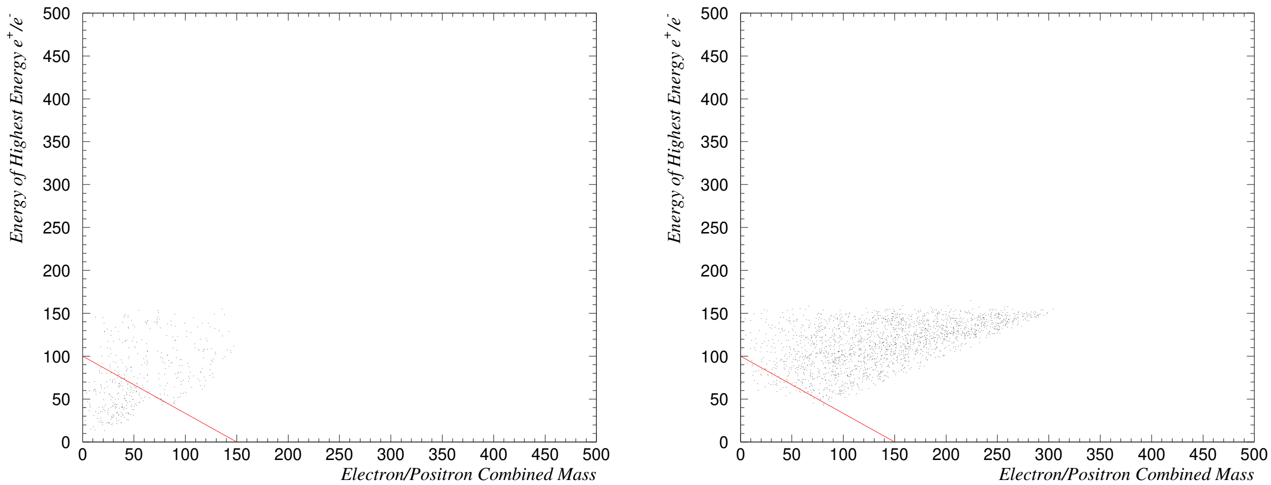
- The simulated Standard Model backgrounds and cross sections are shown above.

Cuts Reducing the Supersymmetric Background

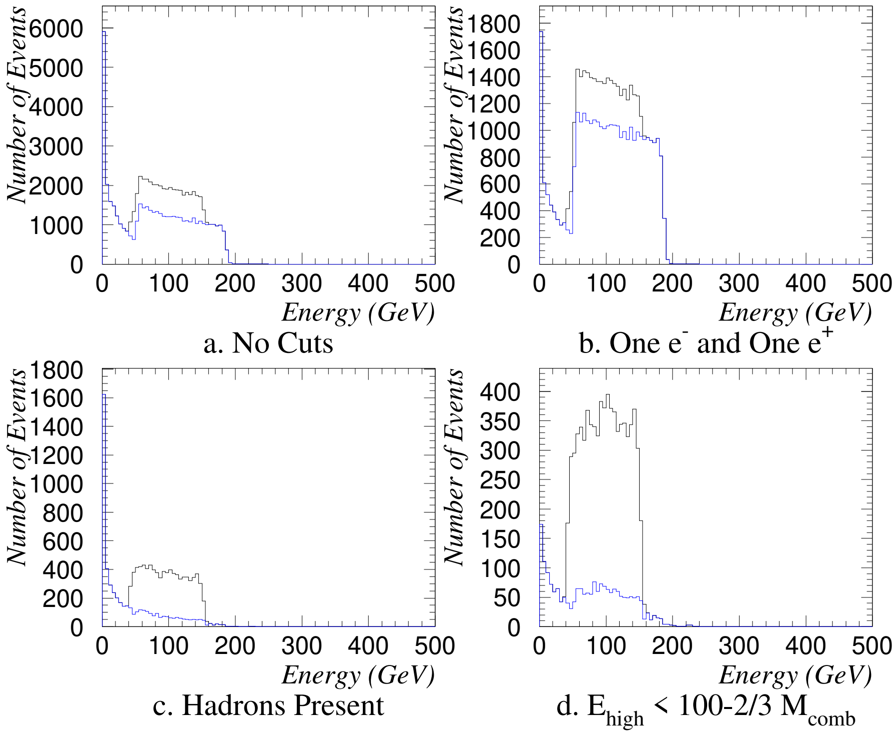
- Require exactly one e^+ and one e^- in addition to whatever other particles are in the event.

- Require that hadrons be present in the event. This eliminates $e^+e^- \rightarrow \tilde{e}^+\tilde{e}^-$ events.

- Require all events lie above the red line in the figures below. The first plot depicts Supersymmetric background events while the second depicts the signal.



Energy distribution of e^+ and e^- after supersymmetric cuts. Black is all supersymmetry and blue is only supersymmetric background. event.



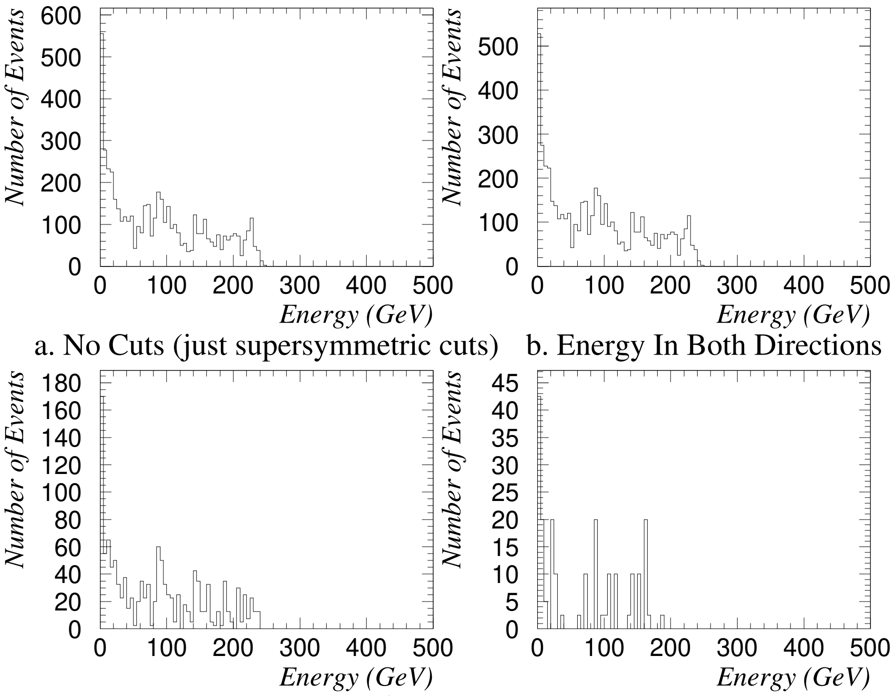
Cuts Reducing Standard Model Background

• Remove events with *no* energy in one hemisphere. This removes Standard Model events which are often very forward. The electrons from these Standard Model events often go down the beam pipe and are not detected.

• Remove events with more than 1 GeV within the region $.90 < |\cos\theta| < .99$. This also removes forward Standard Model events.

• If all energy were visible, we would expect 50% of the center of mass energy to be visible in the forward hemisphere. In a supersymmetric event, we expect less than this. Thus we require that the forward hemisphere has 40% E_{CM}.

Energy distribution of e^+ and e^- from Standard Model events after Standard Model cuts

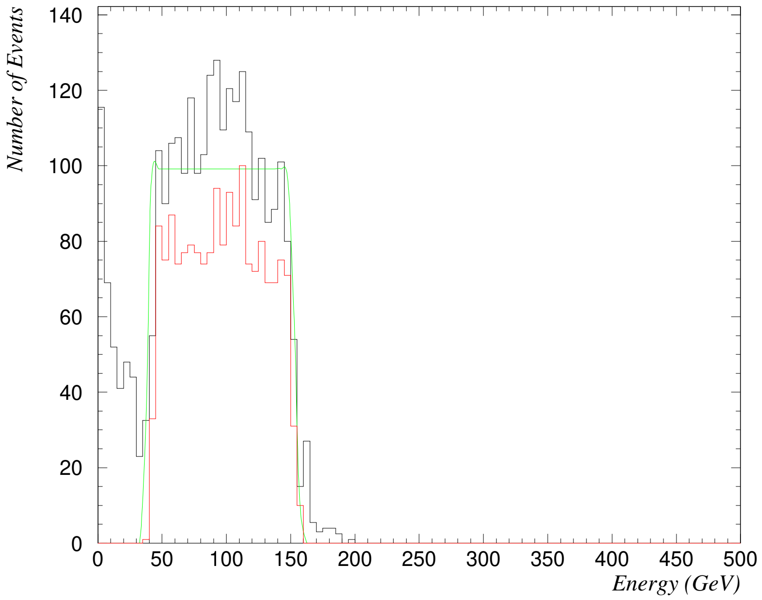


a. No Cuts (just supersymmetric cuts) b. Energy In Both Directions

c. < 1 GeV With .9 < Cos(θ) < .99 d. Forward Energy < 40% E_{cm}

Mass Measurement

- Energy distribution of e^{+} and e^{-} after all cuts. Red is the signal, black is the total.



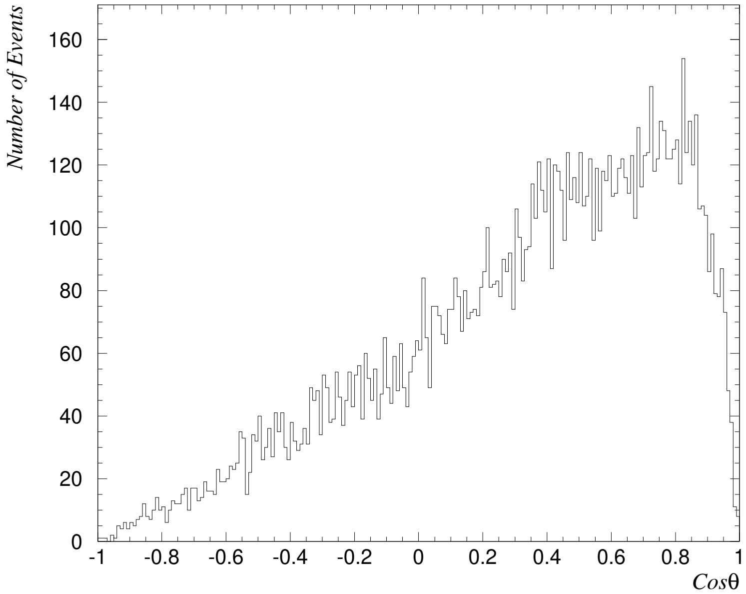
Expected Masses: $M_{\tilde{\chi}_1^+}$ =96.4 GeV, $M_{\tilde{\nu}_e}$=206.6 GeV

Measured Masses: $M_{\tilde{\chi}_1^+}$ =96.5 GeV, $M_{\tilde{\nu}_e}$=199.4 GeV

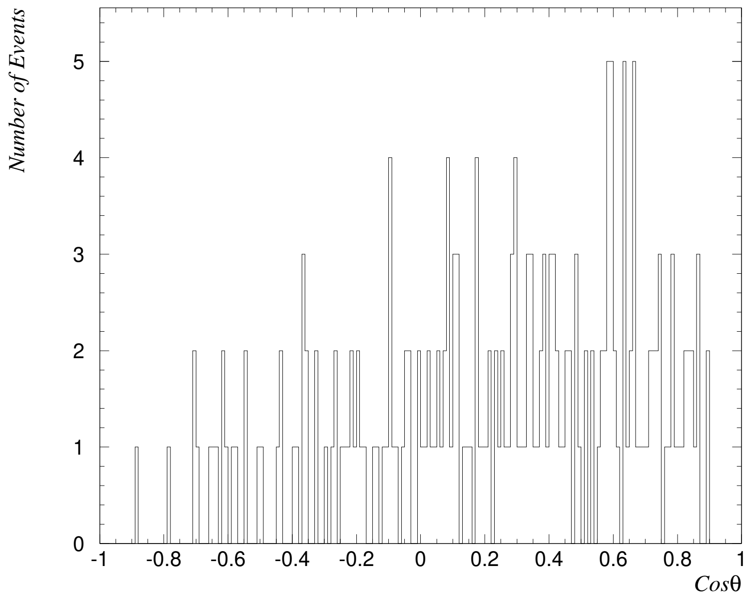
Angular Distribution

• The $\tilde{\nu}_e\overline{\tilde{\nu}}_e$ process is mediated by a $\tilde{\chi}_1^+$. If the $\tilde{\chi}_1^+$ were massless we would expect the $\tilde{\nu}_e$to have an angular distribution $\propto 1/\sin^4\frac{\theta}{2}$.

• However, the $\tilde{\chi}_1^+$ is massive, so we would expect an angular distribution with a peak at an angle $\cos\theta < 1$.



• The e^+s and e^-s with the highest energy are the ones that happen to be travelling in the same direction as the $\tilde{\nu}_e$. So the energy distribution of these high energy e^+s and e^-s should have the same angular distribution.



• Although there are few statistics after a year of running, this angular distribution can be seen.