$\chi_1^+\chi_1^- \rightarrow \ell^\pm jj(g)$

Each chargino decays into a virtual W^* and an LSP neutralino. We can read off the chargino-neutralino mass difference from the upper edge in the W^* mass distribution and determine the neutralino mass itself from the shape of the W^* lab-frame energy distribution. Rather than relying on jet algorithms to reconstruct the W^*, we can consider only events where one W^* decays leptonically and the other hadronically— this way the total four-momentum in the event, minus the isolated lepton, is the four-momentum of the W^* (neglecting lost particles).

Because a muon chamber was not implemented in the detector Monte Carlo, we could only study $e^\pm jj(g)$ events, but $\mu^\pm jj(g)$ will only add a factor of two to the final yield. Electrons were identified as tracks matched to electromagnetic clusters within 10% of $E/p = 1$. These are the rest of the cuts:

- Missing energy > 300 GeV (to eliminate most Standard Model backgrounds)
- Transverse momentum > 15 GeV (to eliminate most $\gamma\gamma$ and $e^\pm\gamma$ backgrounds)
- Number of tracks > 10 (to make sure that at least one W^* has decayed hadronically)
- Separation angle between electron track and all other tracks > 30 degrees
- Electron energy > 15 GeV
- Electron $|\cos\theta| < 0.8$ (to cut tagged $\gamma\gamma$ and $e^\pm\gamma$ backgrounds)
- W^* $|\cos\theta| < 0.8$ (to cut most Standard Model W^+W^-)
- W^* invariant mass < 70 GeV (to cut the rest of them)

The branching fraction for $\chi_1^+\chi_1^- \rightarrow e^\pm jj(g)$ is 15% (entirely dominated by the leptonic and hadronic W branching fractions), and the efficiency for such a final state to pass the above cuts is 36%. The branching fractions and efficiencies do not depend on the polarity of the incident beams, but because $\chi_1^+\chi_1^-$ production prefers left-handed electrons by a ratio of 8:1, the final yields do. The yields and backgrounds are listed in Table 1 and the last cut is plotted in Figure 1. Despite the preference for left-handed production, it is still favorable to combine the left-handed and right-handed datasets for a 1% cross-section measurement, after background subtraction. (This 1% is further reduced by a factor of $\sqrt{2}$ if the $\mu^\pm jj(g)$ mode is included.)

The chargino-neutralino mass difference could be read off the W^* invariant mass plot (Figure 1) if it were not blurred by detector resolution. Even if this wasn't a problem, the dependence of the absolute neutralino mass on the W^* lab-frame energy is far from simple, so some kind of fitting procedure must be applied to both distributions to extract the masses. We implemented a fitter which assumes a neutralino mass, a chargino mass, and a [vector-axial?] parameter ζ to generate 2-D distributions of the W^* invariant mass and lab-frame energy, which can then be fit to the data. The W^* mass is generated using [Andreas's distribution], and its energy is derived from energy conservation, accounting for energy lost to initial state radiation and beamstrahlung and the neutralinos. Naturally, the beam energy

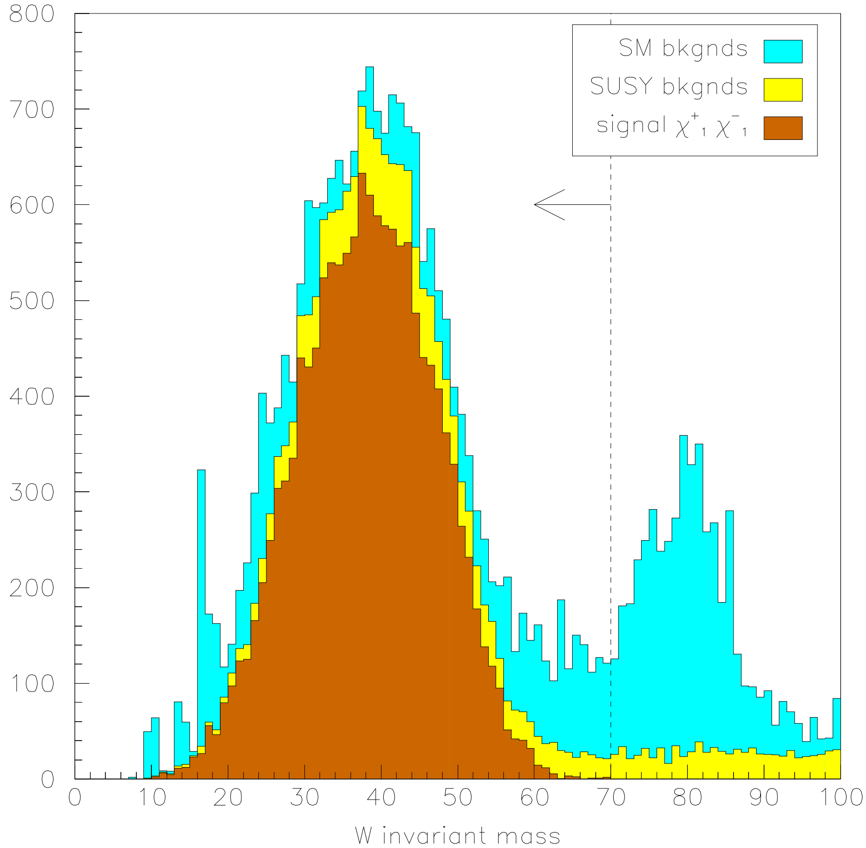

Figure 1: The last cut in the $\chi_1^+\chi_1^- \to \ell^\pm jj(g)$ analysis, showing background contributions stacked on top of the signal. (Both polarizations are combined.)

	left-pol.	right-pol.
Signal ($\chi_1^+\chi_1^- \to e^\pm jj(g)$)	12421	1592
SUSY backgrounds (including $\chi_1^+\chi_1^-$ to other modes)	1751	480
Standard Model backgrounds	3170	1209
Cross-section measurement	940 ± 10 fb	119 ± 4.3 fb

Table 1: The signal and background yields for both incident-electron polarizations and the uncertainty on the cross-section measurement. The uncertainties can be reduced by a factor of $\sqrt{2}$ if the $\mu^\pm jj(g)$ mode is also included. ($\mu^\pm jj(g)$ is not a significant contribution to the SUSY backgrounds.)

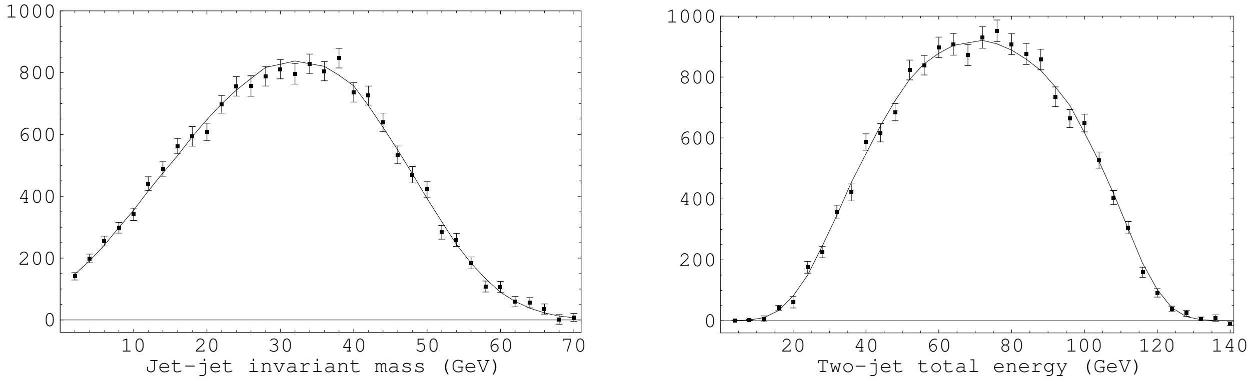

Figure 2: Projections of the 2-D W^* invariant mass/lab-frame energy distribution, overlaid on mock background-subtracted data. (ζ was chosen to be 0.9.)

loss needs to be understood very well to apply this procedure in a realistic environment. To approximate detector effects, the W^* invariant mass is convolved with a 8.4 GeV Gaussian and the W^* lab-frame energy is independently convolved with a 6.0 GeV Gaussian. These resolutions and their independence were derived by comparing the measured W^* mass and energy with their generator values in the Monte Carlo.

In this fitting example, the statistical errors on the data are the square root of the number of events left after cuts, inflated by background subtraction. Because it would slow down the fitting procedure, event cuts were not simulated in the fitter. The event cuts sculpt the shape of the energy and mass distributions, so the "data" distribution to which we fitted was actually generated by the fitter: it is a no-cuts distribution with naïve resolution. All these effects left out of the fitter can bias the final fit, so this study is completely insensitive to any systematic errors that would plague a real experiment. These uncertainty predictions, therefore, must be understood as purely statistical. Projections of the generated distribution overlaid on the nominal fit are shown in Figure 2.

The results of this fit are shown in Figure 3 and Table 2. Because the upper edge of the mass distribution is sensitive to the mass difference, the difference is much better constrained than either mass. ζ dramatically widens the shape of the invariant mass distribution, so it is very well constrained, but it doesn't interfere with the location of the upper edge, so it can be fitted independently.

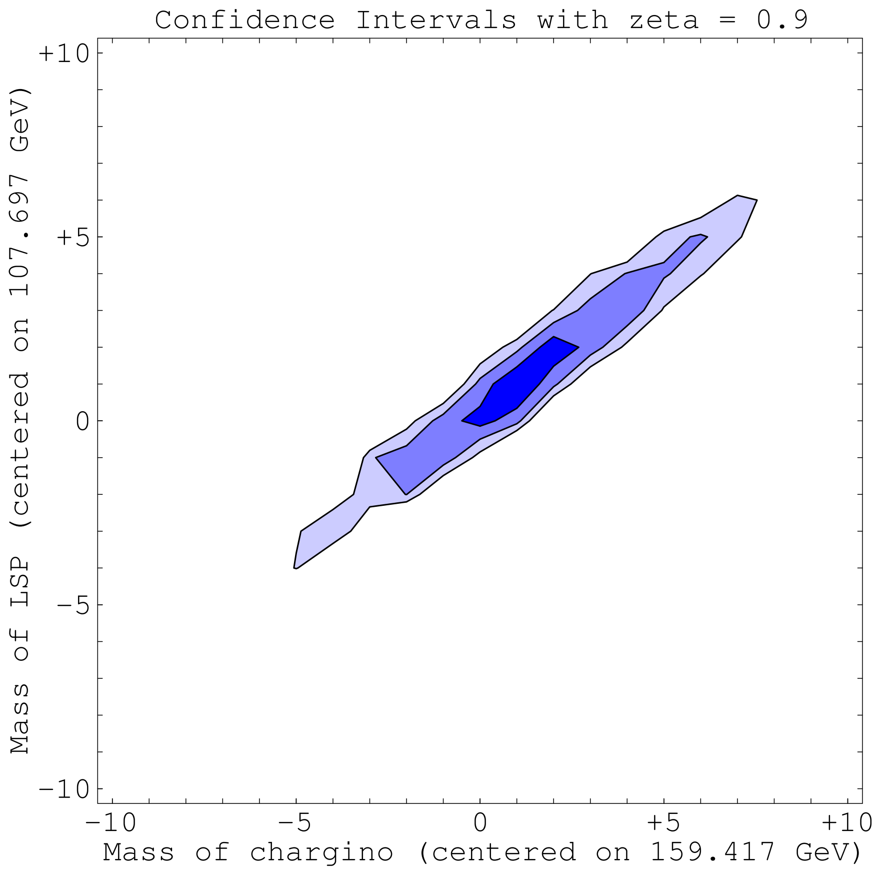

Figure 3: One-, two-, and three-sigma contours in chargino and neutralino mass with $\zeta = 0.9$. This plot is centered on the input mass values and is gradated in units of GeV.

LSP neutralino mass ($m_{\chi_1^0}$)	± 1.1 GeV
chargino mass ($m_{\chi_1^\pm}$)	± 1.9 GeV
mass difference ($m_{\chi_1^\pm} - m_{\chi_1^0}$)	± 0.4 GeV
mass sum ($m_{\chi_1^\pm} + m_{\chi_1^0}$)	± 1.8 GeV
ζ (vector-axial thingy, set to 0.9)	± 0.012

Table 2: Sensitivities to and correlations between chargino and neutralino masses. (ζ was fit independently of $m_{\chi_1^0}$ and $m_{\chi_1^\pm}$.)