# Search for Supersymmetry in the Trilepton Channel $q\bar{q} \to \tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to 3\ell + \not{E}_T$ with the DØ Detector at TeVatron Run II

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In the mSUGRA unified model, the sleptons ($\tilde{\ell}$), the lighter charginos ($\tilde{\chi}_1^{\pm}$) and the lighter neutralinos ($\tilde{\chi}_1^0, \tilde{\chi}_2^0$) are typically less massive than gluinos and squarks. Therefore, the signal with three leptons and missing transverse energy ($3\ell + \not{E}_T$) in the final state, from associated production and decay of $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$ is one of the most promising channels for supersymmetric (SUSY) particles searches at the TeVatron $p\bar{p}$ collider. The $\tilde{\chi}_1^{\pm}$ $\tilde{\chi}_2^0$ decays can proceed via electroweak bosons $Z^*$, $W^*$ or via sleptons (Fig. 1).

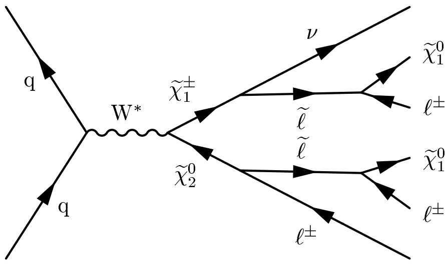


Fig. 1: Feynman diagram for associated $\tilde{\chi}_1^{\pm}$ $\tilde{\chi}_2^0$ production and subsequent decay to $3\ell + \not{E}_T$ final state.

In this analysis only the decay channel with two muons, an additional charged lepton and $\not{E}_T$ in the final state is investigated. Furthermore the most sensitive mSUGRA parameter space is $m_{1/2} < 250$ GeV, $m_0 < 200$ GeV and $\tan\beta < 10$ [1].

At the DØ experiment muons are detected in the muon system and matched to tracks identified with the inner detector. The muon detector itself consists of scintillator counters and drift tubes, with effectively complete coverage out to $|\eta| \leq 2$. The detector is split at $|\eta| = 1$ into a central and forward system. The muon detector has a poor detector redundancy in the bottom part of the central region because of segment support structures. New scintillator counters were installed to improve the coverage of this region [2,3].

The Standard Model (SM) processes with at least two muons in the final state plus an additionally reconstructed 'fake lepton' can be background to the SUSY signal $q\bar{q} \to \tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to \mu^+\mu^-\mu^{\pm}(\mu^+\mu^- e^{\pm}) + \not{E}_T$.

The most important backgrounds for this selection are $Z \to \mu\mu$ and $Z \to \tau\tau$ and can be greatly reduced with a simple cut-based selection. Backgrounds from $tt \to \mu\mu$, $WW \to \mu\nu\mu\nu$ and $WZ \to \mu\nu\mu\mu$ are irreducible but negligible due to their small cross section.

In this analysis the data sample collected with the DØ detector from August 2002 till July 2003 was used, corresponding to the integrated luminosity of $L = 108$ pb$^{-1}$.

The supersymmetric (SUSY) signal has three isolated muons with rather low transverse momenta in the range of $5 \leq p_T[\mathrm{GeV}] \leq 30$. The preselection consists of events with two muons tracks satisfying the muon quality cuts. The two muons must have a transverse momentum of $p_T > 12$ and $p_T > 7$ GeV and must be isolated.

The invariant mass spectra of two opposite signed muons $M_{\mu\mu}$ reflects the mass difference of the lightest neutralinos $\tilde{\chi}_1^0\tilde{\chi}_2^0$ (Fig. 2).

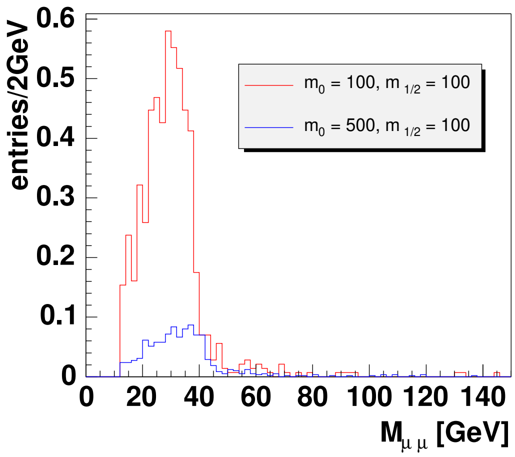


Fig. 2: The invariant mass spectra of the two opposite signed muons for the SUSY signal at $tan\beta = 2$ and $sign(\mu) < 0$, (L = 200 $pb^{-1}$).

After the preselection the spectra of expected backgrounds from SM processes agree with the data (Fig. 3: SM backgrounds are normalized to the integrated luminosity).

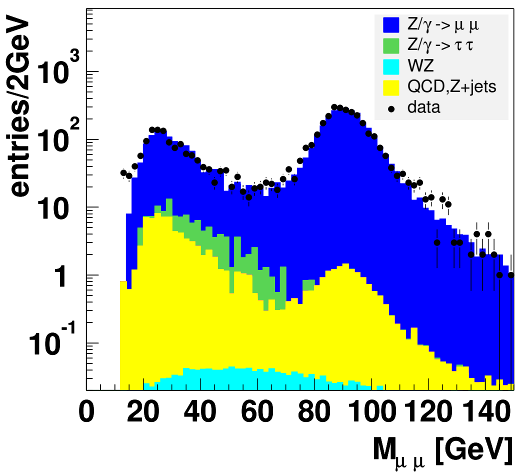


Fig. 3: The invariant mass spectra of the two opposite signed muons for SM background and data.

Only events with a third charged lepton (muon or electron) and large missing transverse energy (due to the stable lightest supersymmetric particle $\tilde{\chi}_1^0$ and the neutrino) are selected for the final analysis. Those cuts eliminate most of the expected SM background processes.

After all cuts, 3 events remain in the data to be compared with 2.58 expected from background processes.

## References

[1] V. Barger, C.E.M. Wagner *et al.*, hep-ph/0003154
[2] DØ Collaboration, B. Baldwin *et al.*, DØ note 3365
[3] DØ Collaboration, G. Alexeev *et al.*, DØ note 3366