J.Krstic, M.Milosavljevic and D.Popovic
Institute of Physics, Belgrade

Right squark search

Due to R parity conservation in mSUGRA models every SUSY event has two lightest SUSY particles which are massive and stable but undetectable, thus causing SUSY decay chains to be incomplete and not adequate for mass measurements. Exclusive supersymmetric signals may be extracted from the kinematic limits of various variables. This technique is applied on the right squark pair events $\tilde{q}_R\tilde{q}_R,\ \tilde{q}_R \to \tilde{\chi}_1^0 q$ where the final state contains two hard light q jets outgoing from the two $\tilde{q}_R$ decays and the missing transverse energy originating from the two lightest neutralinos $\tilde{\chi}_1^0$.

Cambridge m_{T2} variable is defined for the events with the two undetectable decay products. If applied to $\tilde{q}_R\tilde{q}_R$ events, m_{T2} variable is formed from the two final state jets transverse momenta $p_t(j1)$, $p_t(j2)$ and the two dummy vectors $\vec{k}_t(1)$, $\vec{k}_t(2)$ which are introduced due to the unknown transverse energies of the two undetectable $\tilde{\chi}_1^0$ and constrained by the $\vec{E}_t^{miss}$ of the event: $\vec{k}_t(1)+\vec{k}_t(2)=\vec{E}_t^{miss}$. In the case of right squark pair events m_{T2} variable is constructed as:

$$m_{T2}^2 = \min_{\vec{k}_t(1)+\vec{k}_t(2)=\vec{E}_t^{miss}} \left[\max\left\{m_T^2\left(\vec{p}_t(j1),\vec{k}_t(1),m_{\tilde{\chi}_1^0}\right), m_T^2\left(\vec{p}_t(j2),\vec{k}_t(2),m_{\tilde{\chi}_1^0}\right)\right\}\right].$$

The distribution of the m_{T2} variable has the upper kinematical endpoint at the position of the mass of the decaying particle which is $\tilde{q}_R$ in this case.

Right squark pair events represent 4% of all SU4 low mass SUSY events which are used in this analysis. In order to separate $\tilde{q}_R\tilde{q}_R$ events from the SM backgrounds, event selection was performed on pure hadronic events with E_t^{miss}.

Event selection

- no b jets, no e, no μ and no τ leptons;
- 2 light q jets with
  - $p_t(j) > 100$ GeV,
  - $|\eta(j)| < 2$,
  - forming the angle $\Delta R > 1$;
- $E_t^{miss} > 100$ GeV;
- $E_t^{miss}/M_{EFF} > 0.2$.

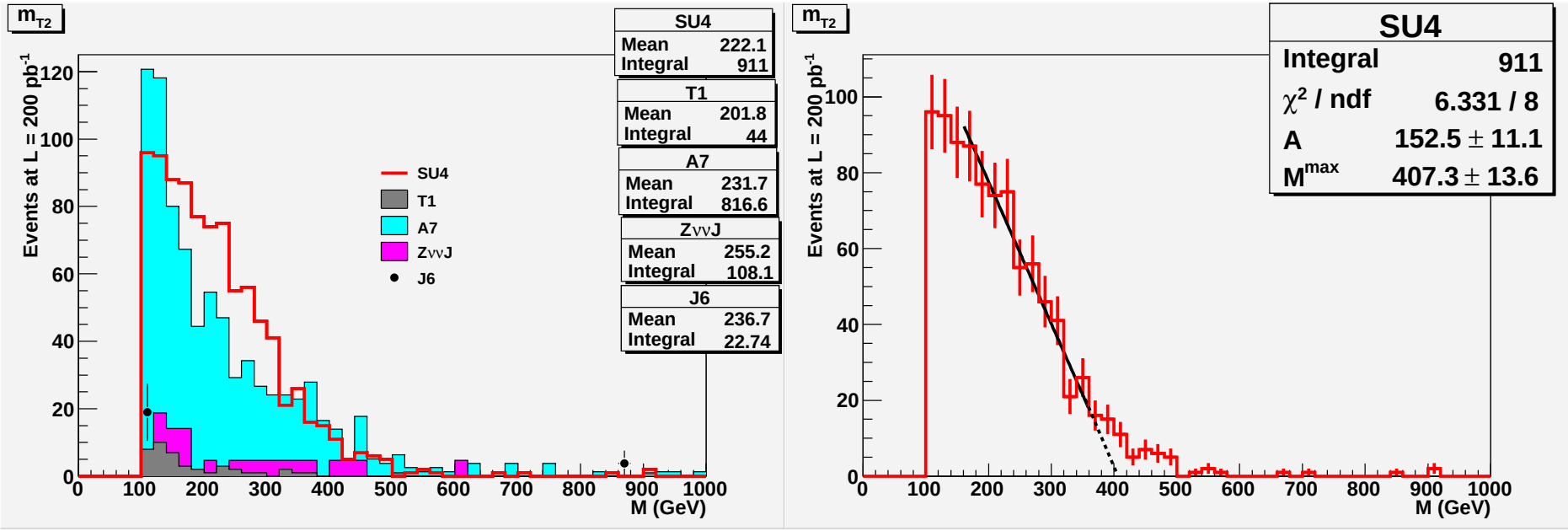
Selection efficiency is estimated to be above 42% for the SU4 right squark pairs, and below 1% for the remaining SM backgrounds. At low luminosity jet tagging efficiency is higher than 90% for $p_t(j) > 20$ GeV.

Most of the remaining background events come from the A7 ($W + jets$) dataset, while the others come from the Zνν̄j, T1 ($t\bar{t}$) and J6 ($multijet$) datasets.

m_{T2} distribution

Reconstructed m_{T2} distribution of the SU4 signal and SM backgrounds satisfying selection criteria (left) and the linear fit of signal m_{T2} distribution (right).

The number of events is normalised to L = 200 pb^{-1} .



Fit: $m(\tilde{q}_R)$ = 407 ± 14 GeV

SU4: $m(\tilde{q}_R)$ = 405 GeV

Results

The upper kinematic endpoint obtained from the linear fit of the SU4 signal m_{T2} distribution is at the position consistent to the predicted right squark mass value. The fit error does not include systematic errors which are mainly originating from the jet energy resolution: $\sigma_E/E = (60-80)\%/\sqrt{E} + (6-8)\%$ and a missing energy resolution: $\sigma = 0.5 \times \sqrt{\Sigma E_t}$. Most of the jets selected for the right squark search have transverse momentum within the interval 100 - 200 GeV. Consequently, a missing energy resolution is estimated to 7 - 10 GeV. For the jet energy domain defined by the same transverse momentum interval and the pseudorapidity cut applied in the event selection, jet energy resolution is estimated to 15 - 20 GeV.

The number of SU4 signal and SM background events satisfying selection criteria and the S/B ratio obtained for $m_{T2} > 150$ GeV, together with the SU4 signal statistical significance SU4/$\sqrt{\text{B}_{SM}}$ at L = 200 pb^{-1}.

Events		S/B
SU4	720	
B_{SM}	693	1.04
SU4/$\sqrt{\text{B}_{SM}}$ = 27.35		

Absolutely dominant remaining SM background process is $W + jets$ which is decreasing S/B ratio to the level close to one. Including only statistical errors on the SM background rates, $\sqrt{\text{B}_{SM}}/\text{B}_{SM}$ = 0.04, the signal significance at the luminosity of only 200 pb^{-1} of data is far above 5 requested for discovery.