Fermilab FERMILAB-CONF-05-610-E

Searches for Squarks and Gluinos at CDF and DØ Detectors

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Abstract. This contribution reports on preliminary measurements on searches for squarks and gluinos at CDF and DØ detectors in $p\bar{p}$ collisions at $\sqrt{s} = 1.96$ TeV. The analyses are performed using event topologies with multiple jets and large missing energy in the final state. The mSUGRA scenario and R-parity conservation is assumed. No excess with respect to the Standard Model predictions is observed and new limits on the gluino and squark masses are extracted.

Keywords: squark, gluino, CDF, DØ, mSUGRA
PACS: 11.30.Pb, 12.60.Jv, 04.65.+e

INTRODUCTION

Supersymmetry (SUSY) [1] is an extension of the Standard Model (SM) that naturally solves the hierarchy problem and, at the same time, provides a good candidate for cold dark matter in the universe. SUSY introduces a fermion-boson symmetry predicting, for every particle in the SM, the existence of a super-partner. In mSUGRA [2], the spectrum of particles is defined by five different parameters: M_0, $M_{1/2}$, A_0, $\tan\beta$ and $sign(\mu)$). When R-Parity (R_P) is conserved, the new supersymmetric particles would be produced in pairs and ultimately decay into the lightest supersymmetric particle (LSP), which is stable and escapes the experimental apparatus undetected. This leads to event topologies characterized by the presence of multiple jets, from the different decays of heavy sparticles, and large missing transverse energy ($\not\!\!E_T$) in the final state, and have been investigated by the CDF [3] and DØ [4] detectors.

BACKGROUND PROCESSES

The supersymmetric signal must be extracted from large background contributions. QCD multijet processes, where the $\not\!\!E_T$ is originated by jets reconstructed in partially instrumented regions of the detector, constitutes one of the most important backgrounds, together with the production of Z and W bosons in association with jets, where the missing transverse energy is originated by the presence of neutrinos in the final state or the misidentification of jets. In particular, $Z \to \nu\bar{\nu}$ + jets constitutes an irreducible background to the supersymmetric signature. In addition, WW and $t\bar{t}$ production, among

[1] Speaker, on behalf of the CDF and DØCollaborations.

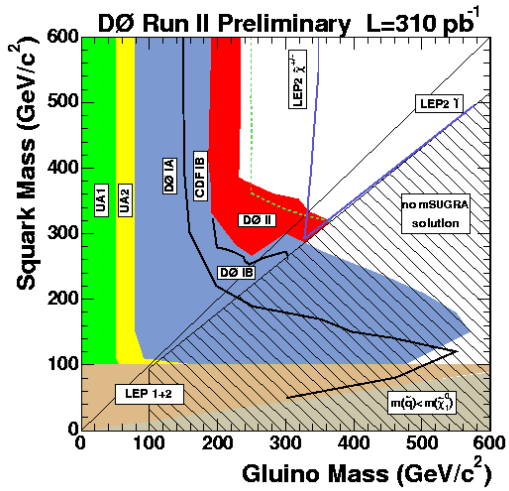

FIGURE 1. 95% CL exclusion regions in the gluino-squark mass plane, where mSUGRA with $\tan\beta = 3, A_0 = 0$ and sign(μ)<0 is assumed.The different shadow bands denote the result of different experiments. The hashed region contains no mSUGRA solution and the dashed line is the expected limit.

others, constitute significant background processes that must be taken into account. DØ and CDF employed two different methods to estimate the dominant QCD background. DØ relies on a fit to an exponential falling shape, based on QCD data at low $\not\!\!E_T$, and extrapolates it to the very high $\not\!\!E_T$ region. CDF decided to generate massive MC samples to take into account non-gaussian tails in the $\not\!\!E_T$ distribution and then, used the data to check the MC absolute yields. For the rest of backgrounds, both experiments extracted predictions from Monte Carlo generators (ALPGEN [5] in the case of Z/W+jets and PYTHIA [6] for WW and $t\bar{t}$ production) normalized to NLO predictions.

EXPERIMENTAL STRATEGIES AND RESULTS

A mSUGRA scenario with $A_0 = 0$, sign(μ) = -1 and $\tan\beta = 3$ ($\tan\beta = 5$) in the case of DØ (CDF) have been assumed. Both experiments applied similar pre-selection cuts to remove cosmics and beam-related backgrounds.

In the case of DØ the analysis was based on 310 pb^{-1} and the cuts were optimized in three different regions of the gluino-squark mass plane. When $M_{\tilde{g}} > M_{\tilde{q}}$, the squark production is enhanced and the final state signature is characterized by dijet events and large missing transverse energy, since the produced squarks tend to decay into a jets and a LSP. When $M_{\tilde{g}} < M_{\tilde{q}}$, the gluino production is more important and the final-state topologies are dominated by the presence of at least four jets. Finally, when $M_{\tilde{g}} \sim M_{\tilde{q}}$ the analysis requires at least 3 jets. In all cases the observed number of events is in good agreement with SM predictions. The resulting limits in the gluino-squark mass plane can be seen in Figure 1.

In the case of CDF, a *blind analysis technique* based on the first 254 pb^{-1} of data was carried out, and the analysis cuts were optimized in a region were the mSUGRA signal was maximal (for $M_{\tilde{g}} \sim M_{\tilde{q}}$ 340 GeV/c^2) . Events were required to have at least

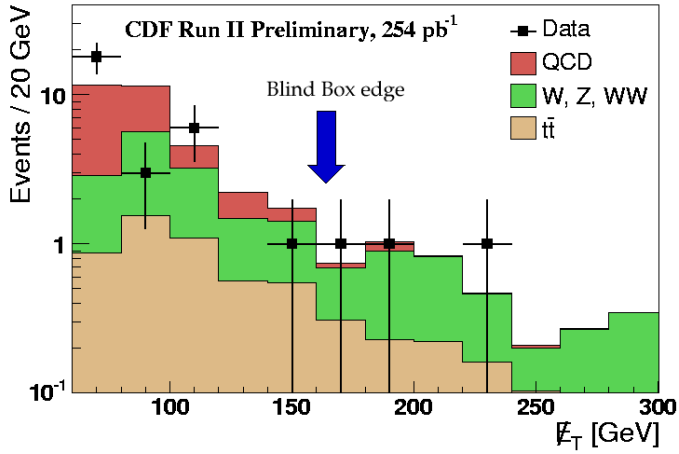

FIGURE 2. $\not\!\!E_T$ distribution for CDF after the rest of the cuts have been applied. The arrow indicates de boundary of the defined signal region for the analysis. The points are the data and the histograms are the different backgrounds, where each includes the previous one and QCD denotes the total SM background.

three jets with a scalar sum of transverse energies above 350 GeV and $\not\!\!E_T$ above 165 GeV. In this case, (see Figure 2) the observed number of events was also found in good agreement with the SM predictions.

SUMMARY AND CONCLUSIONS

CDF and DØ found no evidence for the production of gluinos and squarks in events with multiple jets and large missing transverse energy in the final state based on about 300 pb^{-1} of data. As result, Run I exclusion limits in the gluino-squark mass plane have been significantly expanded.

ACKNOWLEDGMENTS

I would like thank the organizers for the kind invitation and their great hospitality during the conference.

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