Search for scalar bottom quarks and third generation leptoquarks in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.96 TeV

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Search for:

- *Leptoquarks,* predicted by GUTs and composite models. Charge 1/3 scalar leptoquarks LQ_3:
  $LQ_3 \rightarrow \nu_\tau b$ *with a branching fraction B ,*
  $LQ_3 \rightarrow \tau t$ *with a branching fraction 1 – B.*

- *Scalar bottom quarks,* mixtures of $\tilde{q}_R, \tilde{q}_L$.
  Assuming, in the MSSM: $\tilde{b}_1 \rightarrow b \tilde{\chi}^0_1$ *only.*

→ We look for: $p\bar{p} \rightarrow \tilde{b}_1 \bar{\tilde{b}}_1 \rightarrow b \tilde{\chi}^0_1 \bar{b} \tilde{\chi}^0_1$
$p\bar{p} \rightarrow LQ_3 \overline{LQ}_3 \rightarrow b \bar{b} \nu \bar{\nu}$

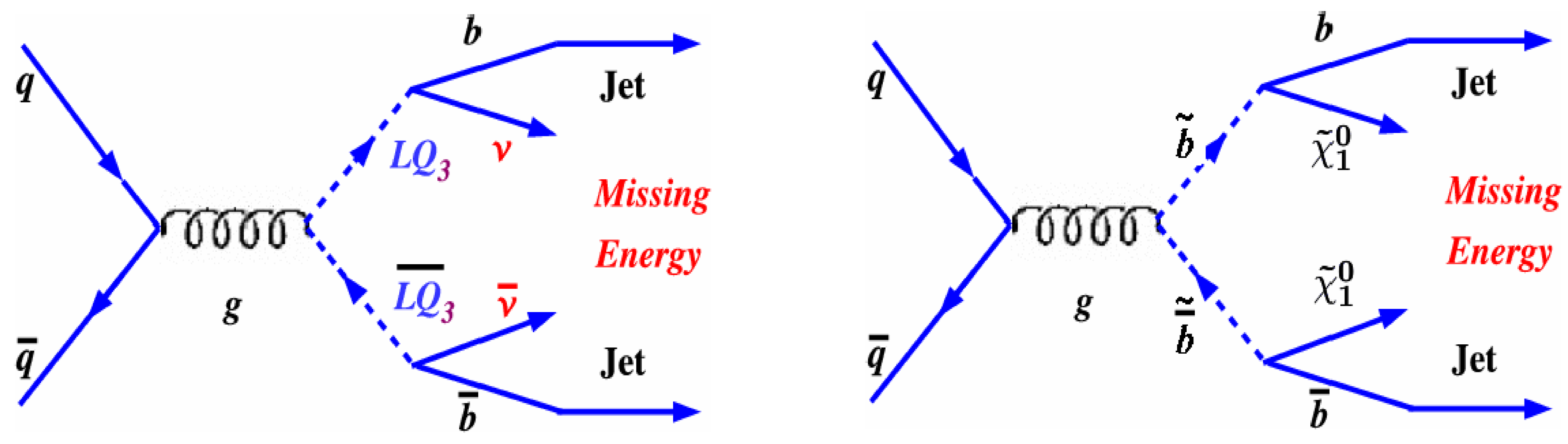

Fig. 1: Feynman diagrams of the signals.

Signal signature: 2 high p_T b-jets + E_T^{mis}

Backgrounds

- *with real E_T^{mis}*: leptonic decays of W/Z+jets with misidentified leptons, evaluated from MC and normalized with a W enriched sample.
- *instrumental*: multijet processes with E_T^{mis} arising from mismeasurements, evaluated from data using a QCD dominated sample.

Event selection

- 2 or 3 jets with p_T > 20 GeV, azimuthal angle (jet$_1$,jet$_2$) < 165°
- veto on events with isolated electrons, muons or taus
- E_T^{mis} > 40 GeV, high E_T^{mis} significance and $\vec{E}_T^{mis}$ not colinear with jets
- cut on the azimuthal distance between $\vec{E}_T^{mis}$ and the missing track transverse momentum $\vec{p}_T^{mis}$
- at least 2 b-tagged jets (one tight, one loose)
- final selections: cuts on E_T^{mis}, p_T^{jet1}, $H_T = \sum_{jets} p_T$ and $X_{jj} = (p_T^{jet1} + p_T^{jet2})/H_T$ depending on m_{LQ_3} and $m_{\tilde{b}_1}$.

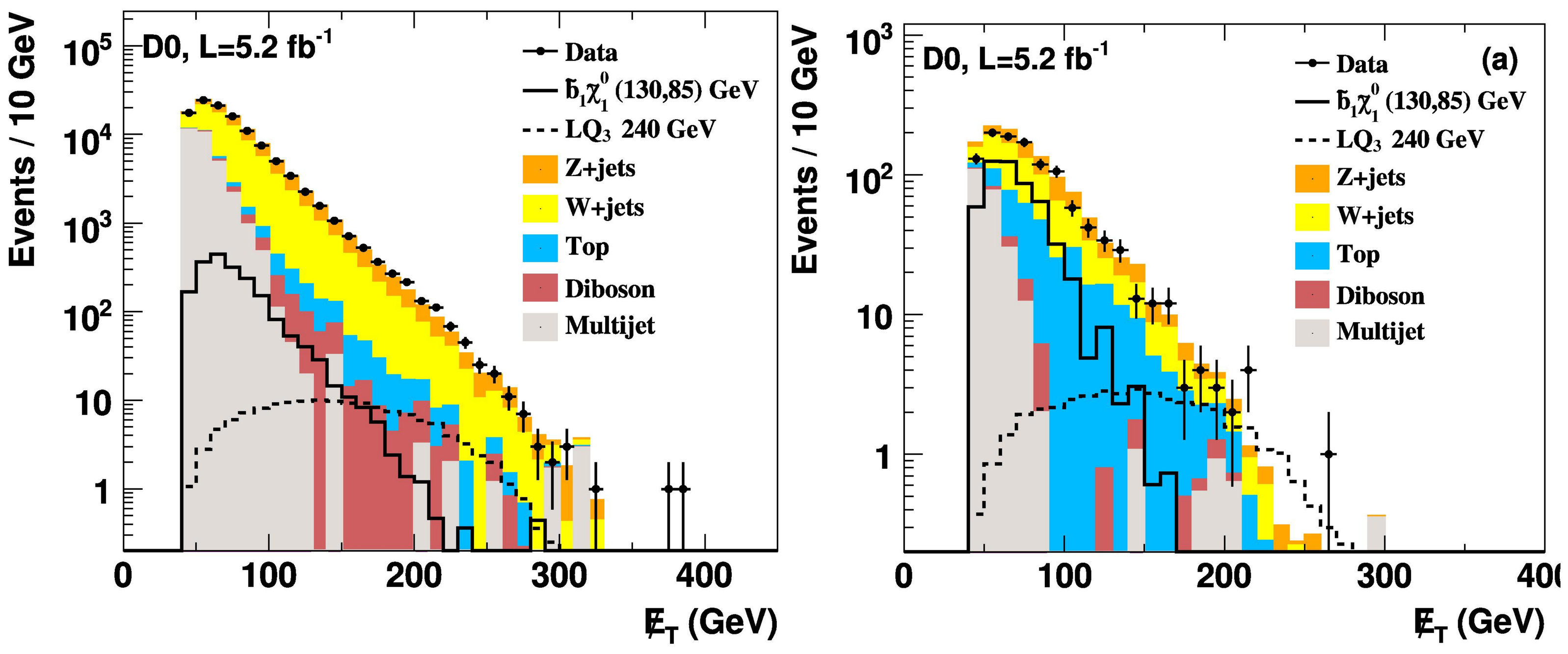

Fig. 2: E_T^{mis} distributions before (left) and after (right) b quark identification.

Systematics
Main systematics come from the uncertainties on the integrated luminosity (6%), the jet energy scale (2-7%), b-tagging (5-17%), theoretical cross-sections for SM processes (6-20%), and the contribution from multijet background (25%).

B-tagging
Use reconstruction of displaced secondary vertices and decay length to separate light and heavy-flavour jets.
At DØ, b-tagging implemented with a neural network: typical efficiency of 55% for a fake rate of 1%.

Process	$X_{jj} > 0.75$, $p_T^{jet1} > 20$ GeV, $\not{E}_T > 40$ GeV, $H_T > 60$ GeV	$X_{jj} > 0.9$, $p_T^{jet1} > 50$ GeV, $\not{E}_T > 150$ GeV, $H_T > 220$ GeV
Diboson	31	0.3
$W(\rightarrow l\nu)$ + light jets	105	0.5
$Wc\bar{c}, Wb\bar{b}$	261	1.9
$Z(\rightarrow ll)$ + light jets	8	0
$Zc\bar{c}, Zb\bar{b}$	217	1.9
Top	190	2.2
MJ	157	0
Total background	971 ± 152	6.9 ± 1.7
# data events	901	7
Signal (acceptance, %)		
$(m_{\tilde{b}_1}, m_{\tilde{\chi}^0_1})$=(240,0) GeV	-	10.5 ± 1.9 (2.8)
$(m_{\tilde{b}_1}, m_{\tilde{\chi}^0_1})$=(130,85) GeV	481 ± 66 (2.7)	-

Table 1: Examples of observed and predicted yields after selection.

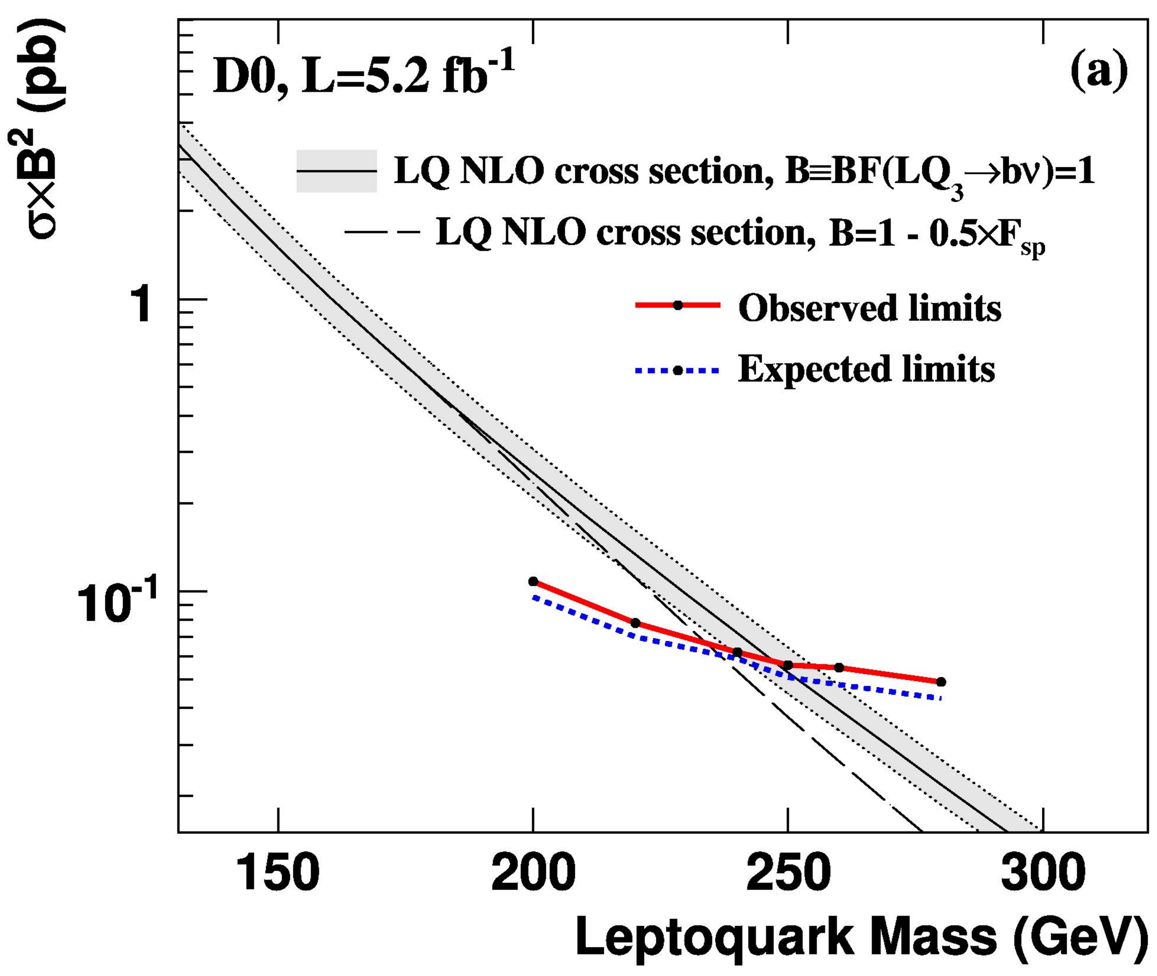

Fig. 3: 95% CL upper limits on the cross section as a function of m_{LQ}.

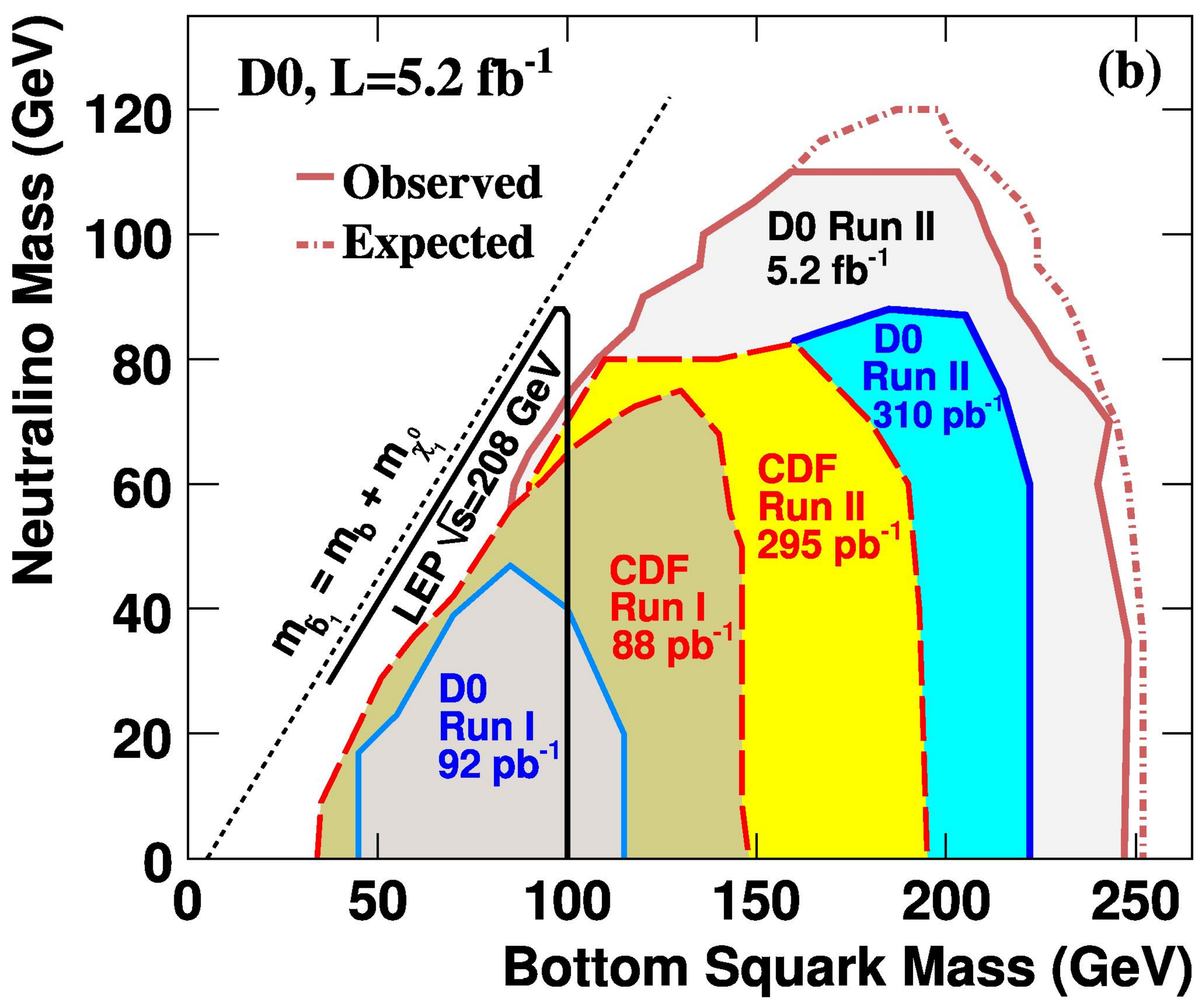

Fig. 4: excluded region in the plane of the bottom squark vs neutralino mass.

Limits and conclusion

- Number of events observed in 5.2 fb^{-1} data sample consistent with the predicted number of events from SM processes (Table 1).
- Limits are computed as a function of the leptoquark mass (Fig. 3).
  The limits set are: m_{LQ3} > 247 GeV for B=1, and 234 GeV if the couplings for $LQ_3 \rightarrow \nu_\tau b$ and $LQ_3 \rightarrow \tau t$ are equal.
- Fig. 4 shows the excluded region in the plane of the bottom squark versus neutralino mass.
  For a massless neutralino, the limit is: $m_{\tilde{b}_1}$ > 247 GeV.
- *These limits significantly extend previous results and are the best to date.*