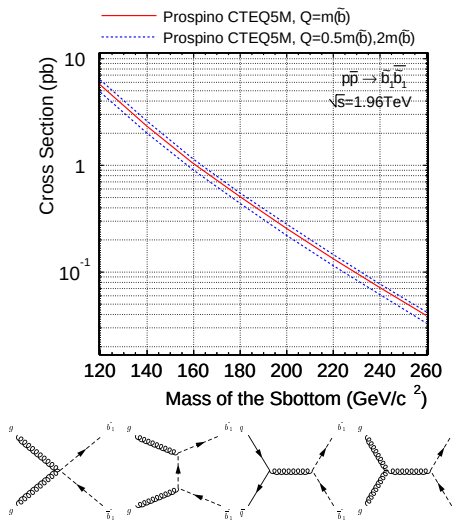
# Search for the Supersymmetric Partner of the Bottom Quark using the CDF Detector at the Tevatron Run II

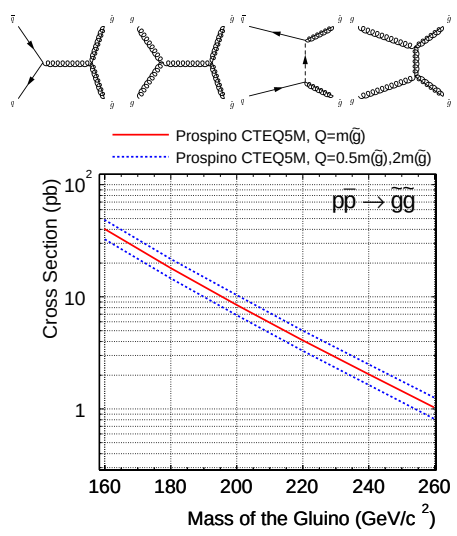
## Sbottom Quark Production at the Tevatron

Sbottom quarks could be produced at the Tevatron in pairs or in a SUSY scenario where the gluino mass is heavier than the sbottom mass through decays of gluinos.

### Sbottom production:




### Gluino production:




## Light Sbottom:

Third generation sparticles could be light, due to large mixing

$$\tilde{q} = \tilde{q}_L \cos\Theta_{\tilde{q}} + \tilde{q}_R \sin\Theta_{\tilde{q}}$$

- Mass matrix mixing term $m_q(A_q - \mu\kappa)$

$\kappa = \tan\beta$ down type quarks

$\kappa = 1/\tan\beta$ up type quarks

→ Light **Stop** — Large mass splitting

→ Light **Sbottom** — Large tanβ

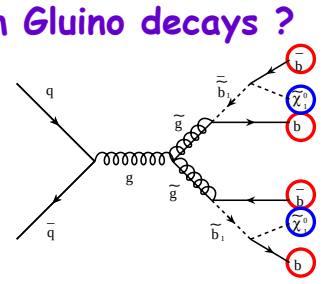
**SUSY parameters:**

- Ratio of vac. exp. values of two Higgs doublets: $\tan\beta$
- gaugino mass parameter: $m_0$
- common mass for scalar fermions at GUT scale: $m_{1/2}$
- Higgsino mixing parameter: $\mu$
- Trilinear coupling in the Higgs sector: $A_0$

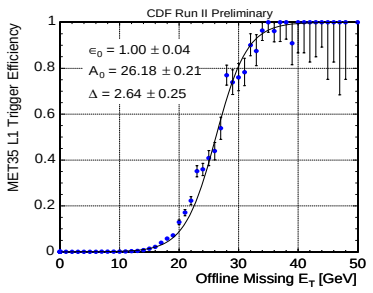
## Why look for Sbottom quarks from Gluino decays ?

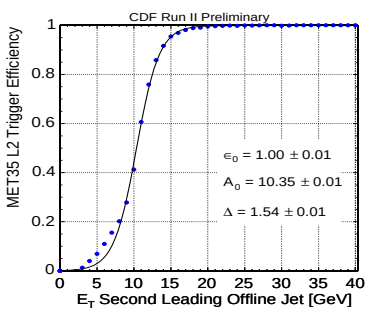
$$\tilde{g}\tilde{g} \to (b\bar{\tilde{b}}_1)(\bar{b}\tilde{b}_1) \to (b\bar{b}\tilde{\chi}_1^0)(\bar{b}b\tilde{\chi}_1^0)$$

- Very distinctive signature (4 bjets + $\not\!\!E_T$) →
- Gluino pair production cross section large




## Trigger Efficiency




MET35 trigger:

- L1: $\not\!\!E_T > 25$
- L2: 2 clusters (10GeV $\eta = (0, 3.6)$)
- L3: $\not\!\!E_T > 35$

Fit function $\epsilon\left(\not\!\!E_T\right) = \frac{\epsilon_0}{1+exp\left(-\frac{\not\!\!E_T - A_0}{\Delta}\right)}$

$\epsilon_0$ asymptotic efficiency

MET35 trigger yields high signal efficiency for gluino-sbottom search

## Analysis Path

In addition to the signal region define three control regions to cross-check background expectations with observed events.

Signature: 4 bjets, $\not\!\!E_T$

Background: bb QCD, Top, W/Z+jets

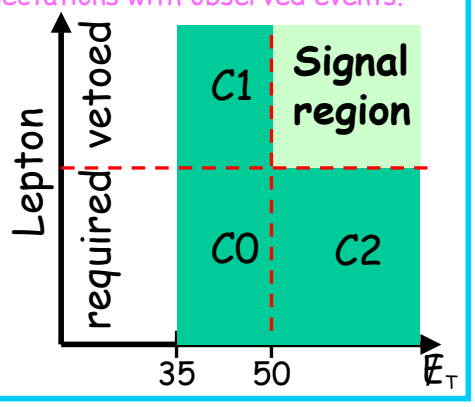
Preselection cuts:

- ≥ 3 jets, (15 GeV, $|\eta|<2$)
- $\not\!\!E_T > 35$ GeV
- Lepton veto → Reduce EWK background
- $\Delta\phi(\not\!\!E_T, \text{jets})$ cuts → Reduce QCD background

Signal Region:

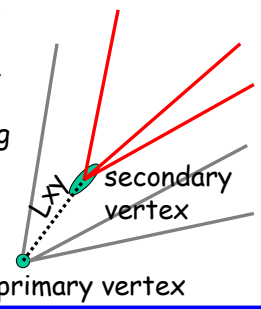
- $\not\!\!E_T > 50$ GeV
- 1 b-tag →
- 2 b-tags

Secondary vertex tagging algorithm used to reduce backgrounds further.




## Secondary Vertex Tagging Algorithm

b-jets are identified using a secondary vertex tagging algorithm. Tracks with large impact parameter are selected and a vertex fitting algorithm is used to reconstruct a displaced vertex.




## Results

Single b-tag

Double b-tag

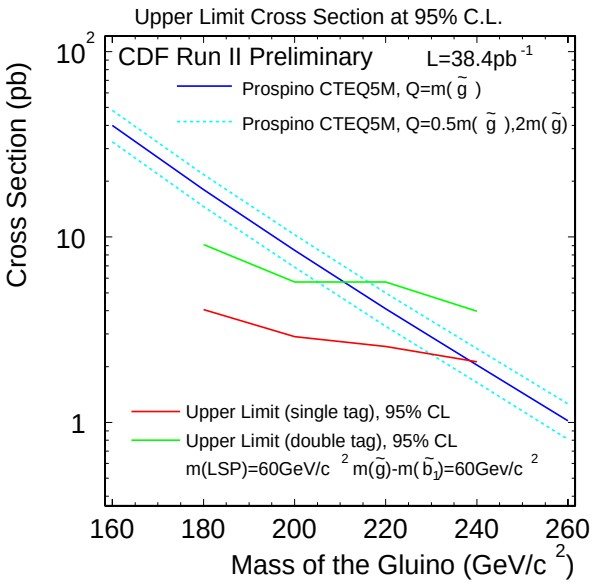
| Region | C0 | | C1 | | C2 | | Signal | |
|---|---|---|---|---|---|---|---|---|
| QCD | 3.8 | 0.1 | 7.3 | 0.2 | 2.0 | 0.0 | 2.8 | 0.1 |
| EWK | 2.7 | 0.1 | 1.5 | 0.4 | 1.6 | 0.1 | 1.4 | 0.1 |
| Top | 1.9 | 0.3 | 0.7 | 0.1 | 4.1 | 0.7 | 1.5 | 0.3 |
| Total bck. | 8.4±1.8 | 0.5±0.1 | 9.5±1.8 | 0.7±0.3 | 7.7±1.5 | 0.8±0.2 | 5.6±1.4 | 0.5±0.1 |
| Observed | 7 | 1 | 8 | 0 | 3 | 0 | 4 | 1 |

QCD dominated

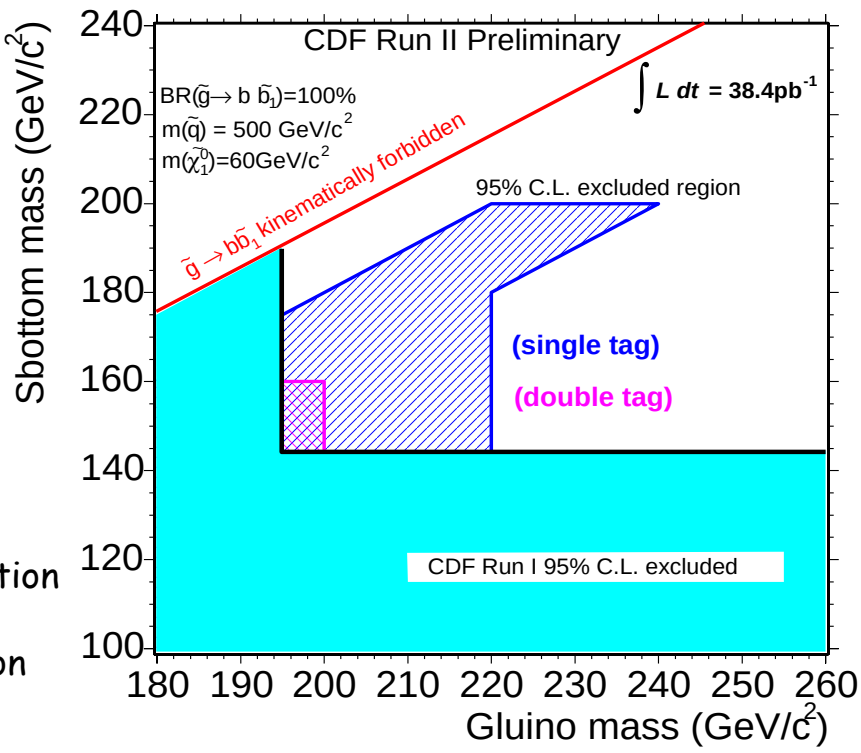
Top dominated

Expected signal events Assuming $m_{\tilde{\chi}_1^0} = 60$ GeV 10.6±1.7

$m_{\tilde{g}} = 220$ GeV $m_{\tilde{b}_1} = 160$ GeV 4.4±0.9




No evidence for gluino pair production with gluinos decaying into sbottom bottom is observed. A new exclusion limit is set.



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