Search for bottom squark cascade decay in 2 electrons +2 jets+ $\not{E}_t$ channel at DÆ

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Outline

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- Signal
- Backgrounds
- Signal Selection
- Results
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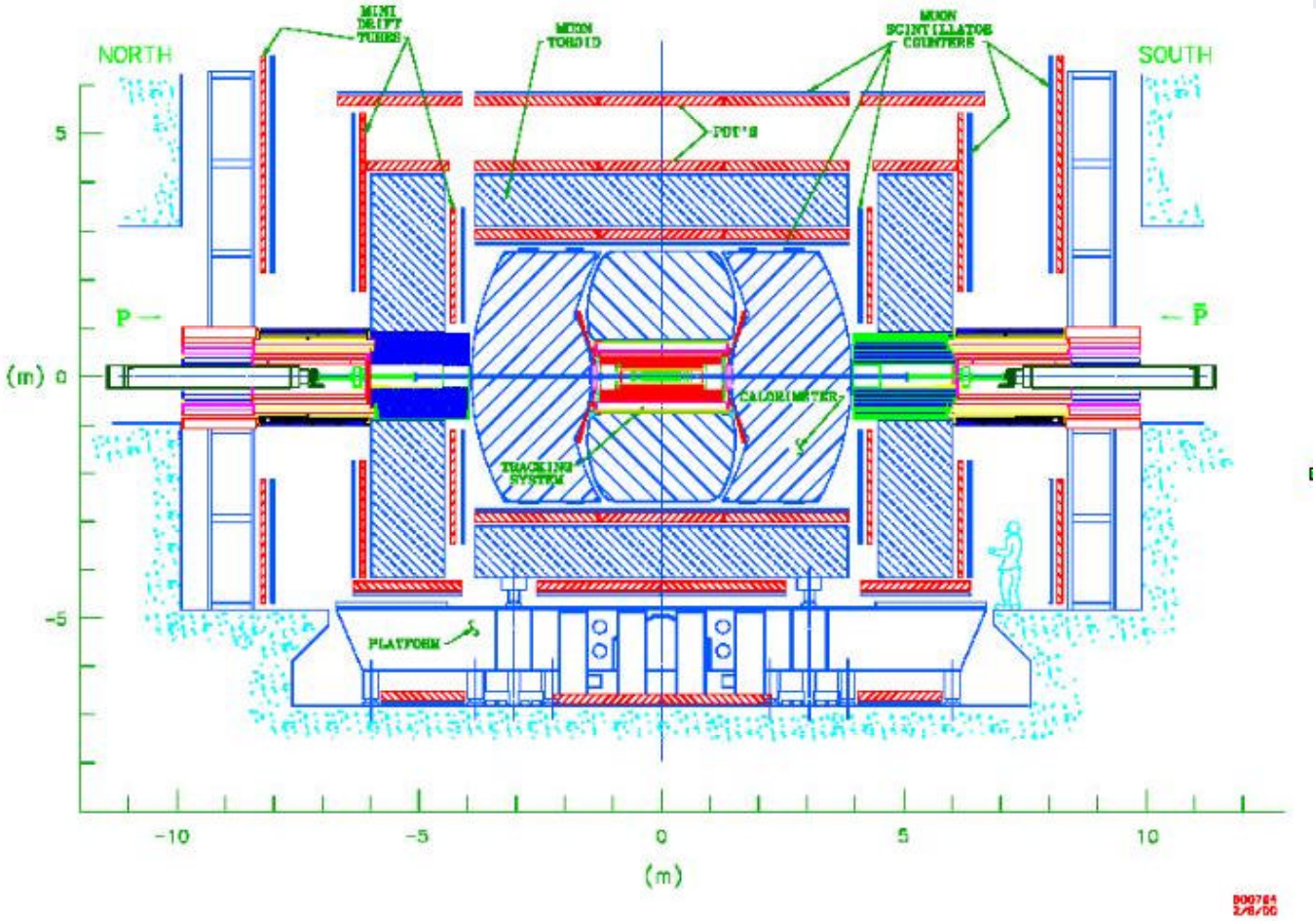
DÆ detector and Data sample



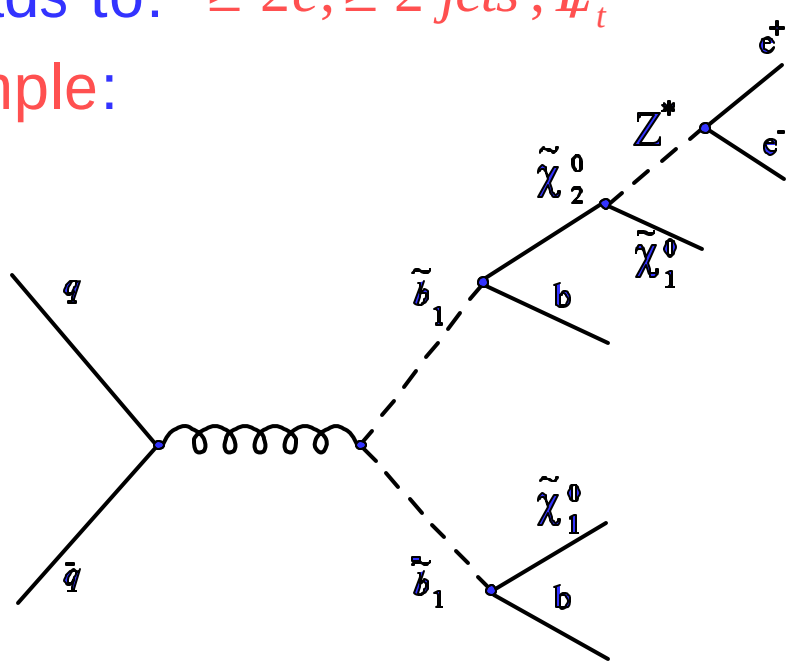
- $p\bar{p}$ at $\sqrt{s} = 1.96$ TeV

- for this analysis:
  - ✓ Trigger=1 EM object and 2 jets
  - ✓ $\Rightarrow \mathcal{L}$ = 42.6 pb^{-1}

Signal

- $\tilde{b}_1$: lightest susy partner of the bottom quark
- mSUGRA model with R-parity conserved and LSP = $\tilde{c}^0_1$.
- production: at least one $\tilde{b}_1$
- decay: $\tilde{b}_1 \rightarrow \tilde{c}^0_2 \, b$
  $\hookrightarrow e^+e^- \tilde{c}^0_1$

  $\Rightarrow$leads to: $\geq 2e, \geq 2\, jets\, , \not{E}_t$
- example:



Signal

- 11 mSUGRA points studied:

$$\begin{cases} m_0 = 100,150,200 \\ m_{1/2} = 50,75,100 \\ signm = -1 \\ \tan b = 2,3 \\ A_{0=} 0,\pm 500 \end{cases}$$

- mass characteristics:
  - ✓ m $\tilde{b}_1 \in$ [130,212] GeV
  - ✓ m $\tilde{c}^0_2 \in$ [58,91] GeV; (m $\tilde{b}_1$- m $\tilde{c}^0_2$) $\in$ [70,135] GeV
  - ✓ m $\tilde{c}^0_1 \in$ [22,43] GeV; (m $\tilde{c}^0_2$- m $\tilde{c}^0_1$) $\in$ [35,48] GeV

- highest σ×BR point:

$$m_0 = 100, m_{1/2} = 50, signm = -1, \tan b = 2, A_0 = 500$$

$$\Rightarrow m_{\tilde{b}_1} = 130\ GeV; m_{\tilde{c}^0_2} = 60\ GeV; m_{\tilde{c}^0_1} = 22\ GeV$$

$$\Rightarrow s \times BR \approx 0.73 pb$$

Backgrounds

- QCD ≥4 jets
- γ + ≥3 jets

} estimated on data

- $\gamma^*/Z^*(\rightarrow e\ e)$ + ≥2 jets
  $\gamma^*/Z^*(\rightarrow \tau\ \tau)$ + ≥2 jets
- $W(\rightarrow e\ \nu)$ + ≥3 jets
  $W(\rightarrow \tau\ \nu)$ + ≥3 jets
- $t\bar{t} \rightarrow e\ \nu\ j\ e\ \nu\ j$
  $t\bar{t} \rightarrow e\ \nu\ j\ j\ j\ j$
- $t\bar{t} \rightarrow \tau\ \nu\ j\ \tau\ \nu\ j$
  $t\bar{t} \rightarrow \tau\ \nu\ j\ j\ j\ j$
- WW, WZ, ZZ

} Monte-Carlo

Samples

- Preselection: ≥1electron(s) +≥2 jets

- ⇒ split in 2 sub-samples:
  - ✓ Exactly 1 electron + ≥ 3 jets = 1e sample (QCD and γ+jets estimation)
  - ✓ ≥ 2 electrons + ≥ 2 jets = 2e sample (analysis sample)

- Cuts:
  - ✓ $Pt(jet_1)$ (corrected) ≥ 40 GeV and jet_1 not in inter-cryostat regions
  - ✓ $Pt(e_1)$ ≥ 25 GeV

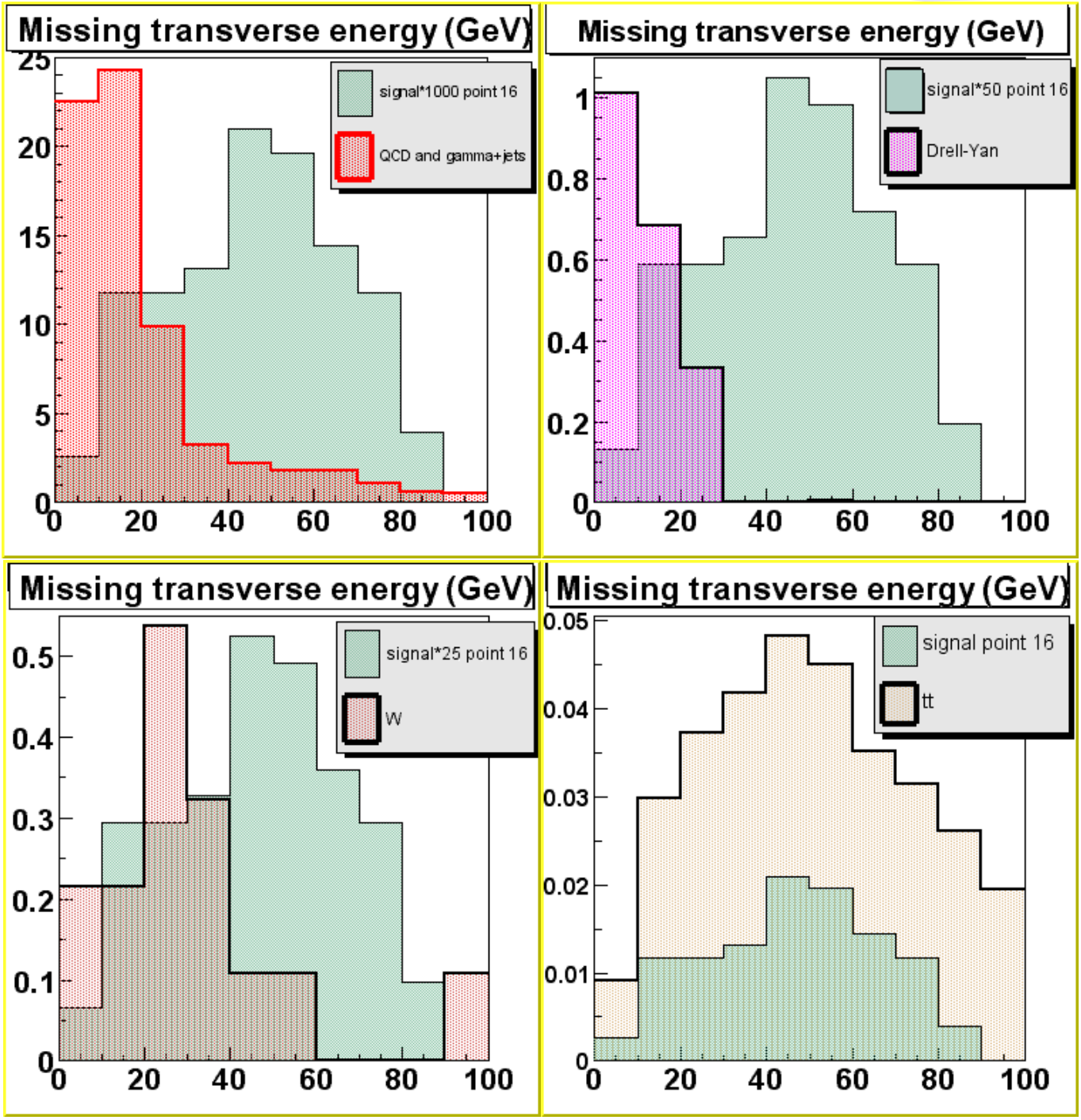
QCD and g+jets estimation

- Assumptions:
  - ✓ for $\not{E}_t$<15 GeV 1e sample is QCD and γ+jets
  - ✓ for $\not{E}_t$<15 GeV 2e sample is QCD and γ+jets + D-Y

- Pseudo di-electron sample:
  - ✓ from 1e sample
  - ✓ from every jet (except the leading one) → one pseudo event with 2 e, one is identified as electron, the second is faked by the jet
  - ✓ event weight = probability for the jet to be misidendified as an electron

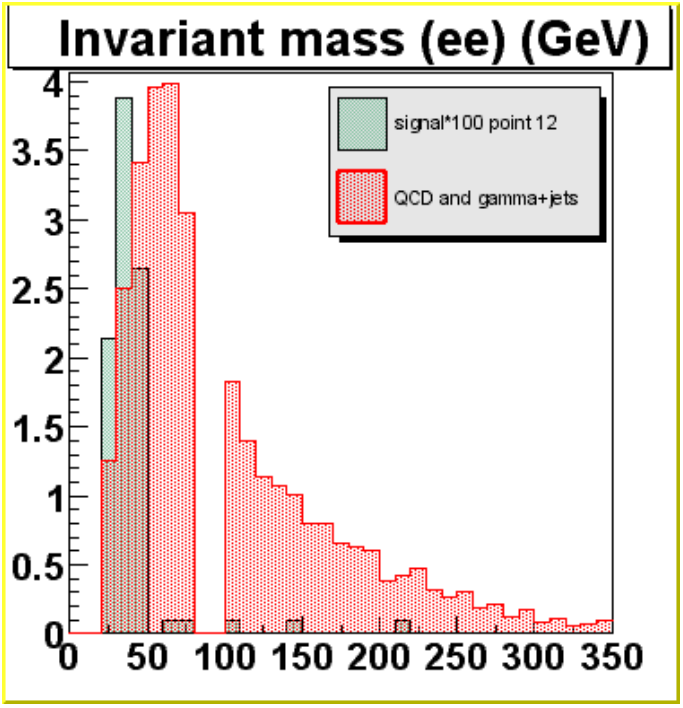
- Normalization:
  - ✓ for
    $\begin{cases} \not{E}_t < 15 \text{ GeV} \\ m(ee) > 20 \text{ GeV and } m(ee) \notin [80\text{-}100] \text{ GeV} \end{cases}$
  - ✓ ⇒ normalize pseudo di-electron sample on 2e sample

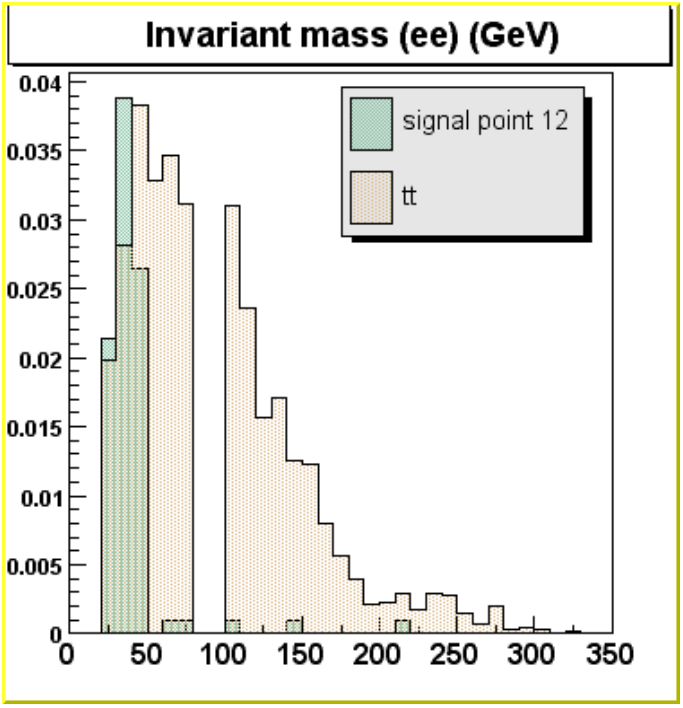
Signal selection: Met cut



- Cut: MET>15 GeV

Signal selection:m(ee) cut



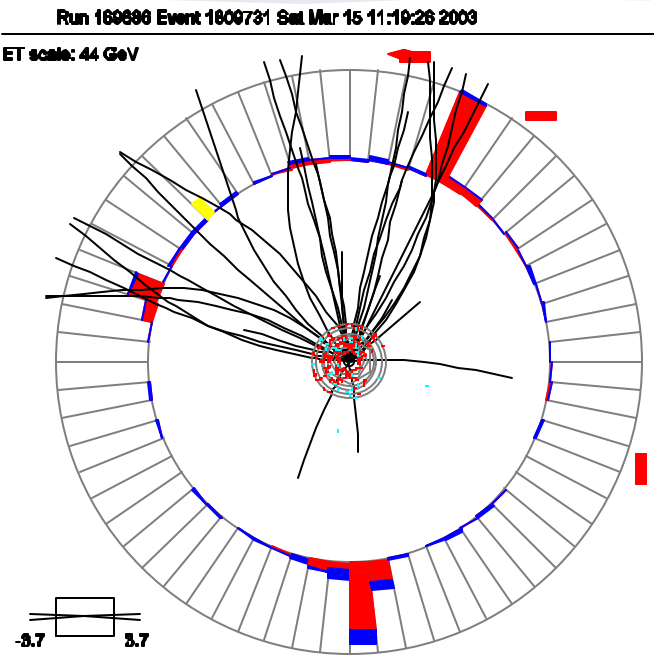


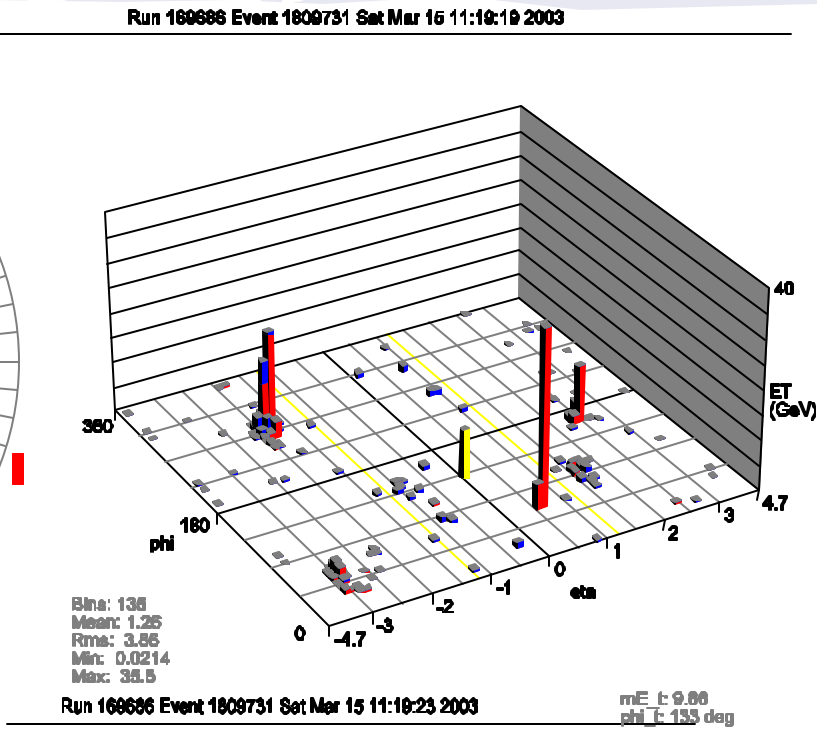
- Cut: m(ee)<100 GeV

Results

	Base cuts	Met>15 GeV	M(ee)< 100 GeV	Trackmatch (for the 2e)
DATA	79	42	26	1
QCD/ γ+jets	68.7	31.7	18.2	$0.049^{+0.008}_{-0.014}$
DY(e e)+jets	1.76	0.85	0.54	$0.21^{+0.37}_{-0.21}$
DY(τ τ)+jets	$6.9\ 10^{-3}$	$5.3\ 10^{-3}$	$3.6\ 10^{-3}$	$0^{+2\ 10^{-3}}_{-0}$
W($e\nu$)+≥3 j	1.40	1.12	0.75	$0^{+0.14}_{-0}$
tt(e n j e n j)	0.21	0.20	0.11	0.062 ± 0.006
tt(e n j j j j)	0.10	0.09	0.05	0.015 ± 0.003
Total bkgd	72.2	34.0	19.7	$0.34^{+0.40}_{-0.21}$

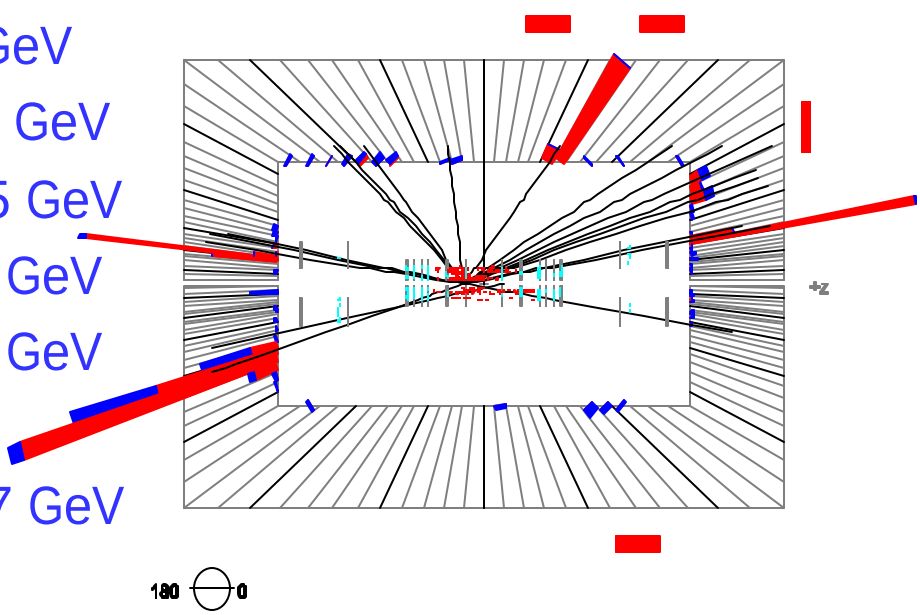
Event display



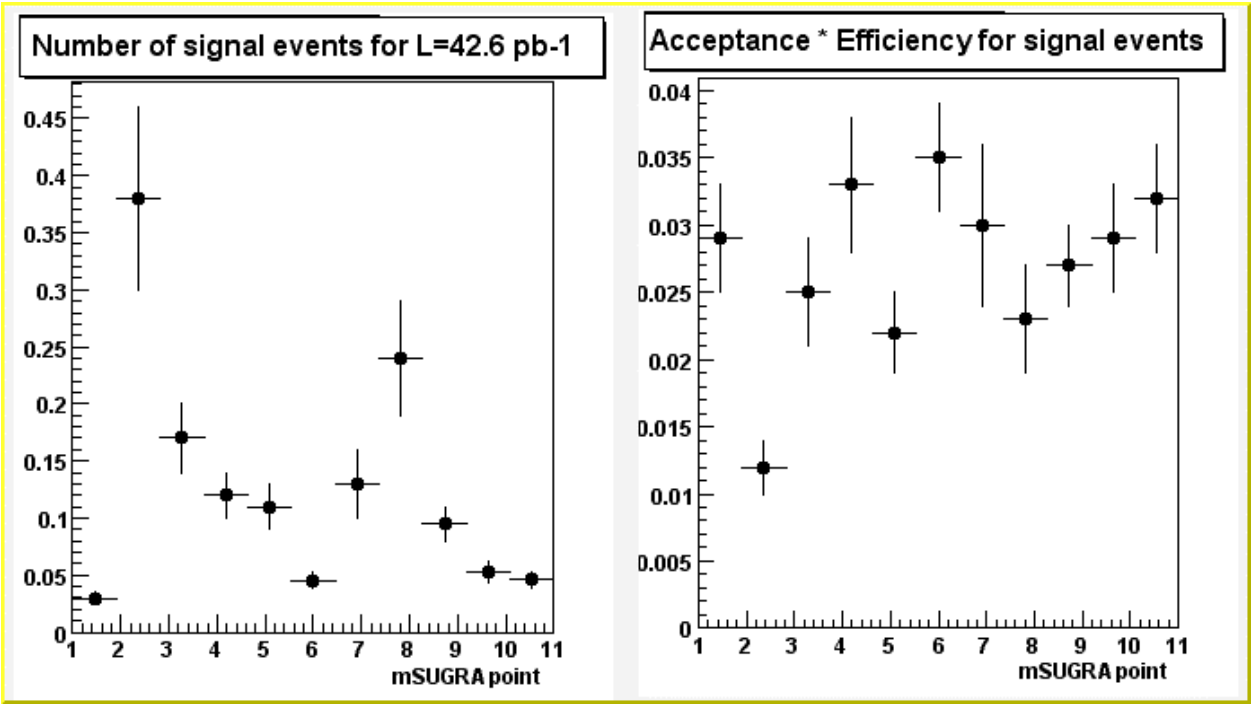


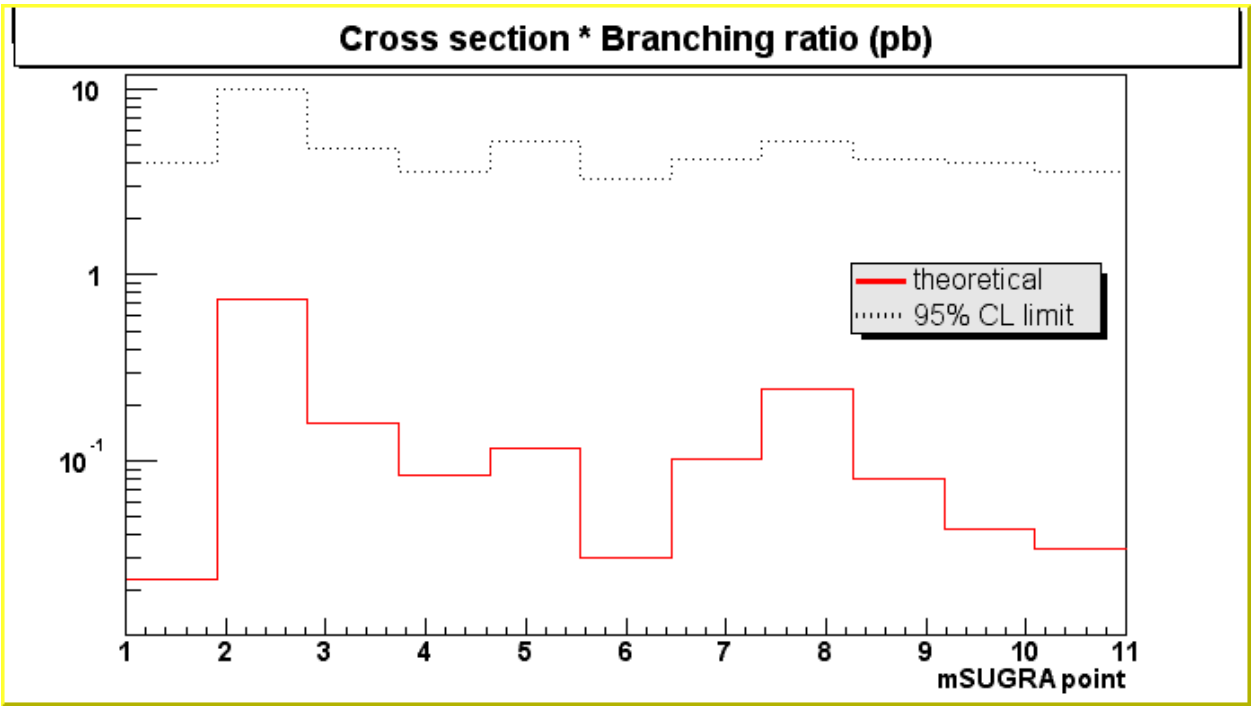
- $\not{E}_t$ = 23.8 GeV
- $E_t(e^-)$ = 41.2 GeV
- $E_t(e^+)$ = 20.5 GeV
- $E_t(j_1)$ = 95.9 GeV
- $E_t(j_2)$ = 19.6 GeV

- M(ee) = 73.7 GeV



Results


Number of signal events for L=42.6 pb-1
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1 2 3 4 5 6 7 8 9 10 11
mSUGRA point
Acceptance * Efficiency for signal events
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1 2 3 4 5 6 7 8 9 10 11
mSUGRA point


Cross section * Branching ratio (pb)
10
1
10^-1
theoretical
95% CL limit
1 2 3 4 5 6 7 8 9 10 11
mSUGRA point

Conclusion

- Search for $\tilde{b}_1$ in cascade decay:
  $\tilde{b}_1 \rightarrow \tilde{c}_2^0 b \rightarrow e^+ e^- \tilde{c}_1^0 b$
  $\Rightarrow$ 2 electrons, 2 jets and $\not{E}_t$ channel

- One event passed all the selection criteria, which is compatible with expected SM backgrounds:
  $0.34^{+0.40}_{-0.21}$ events

- 95% CL limits on
  cross sections $\times$ branching ratios
  for 11 mSUGRA points
  $\Rightarrow$ they cannot be excluded

- This search can be improved significantly in the future.