Compressed SUSY at Tevatron: possibility to probe beyound LEP2

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in collaboration with H.Baer, S.Profumo, X.Tata PRD75 (2007)

Gaugino mass terms in MSSM

- mSUGRA has minimal gauge kinetic function f_{AB}
  $\longrightarrow$ equal gaugino masses at GUT scale
- Motivation for gaugino mass non-universality:
  - non-minimal f_{AB} in SUGRA models,
    e.g. $f_{AB} \ni 1,\ 24,\ 75,\ 200$ in $SU(5)$ SUSY GUTs
  - various string models, e.g. KKLT model
  - extra-dim SUSY GUTs with gaugino mediated SUSY breaking,
    e.g. Dermisek-Mafi $SO(10)$ model

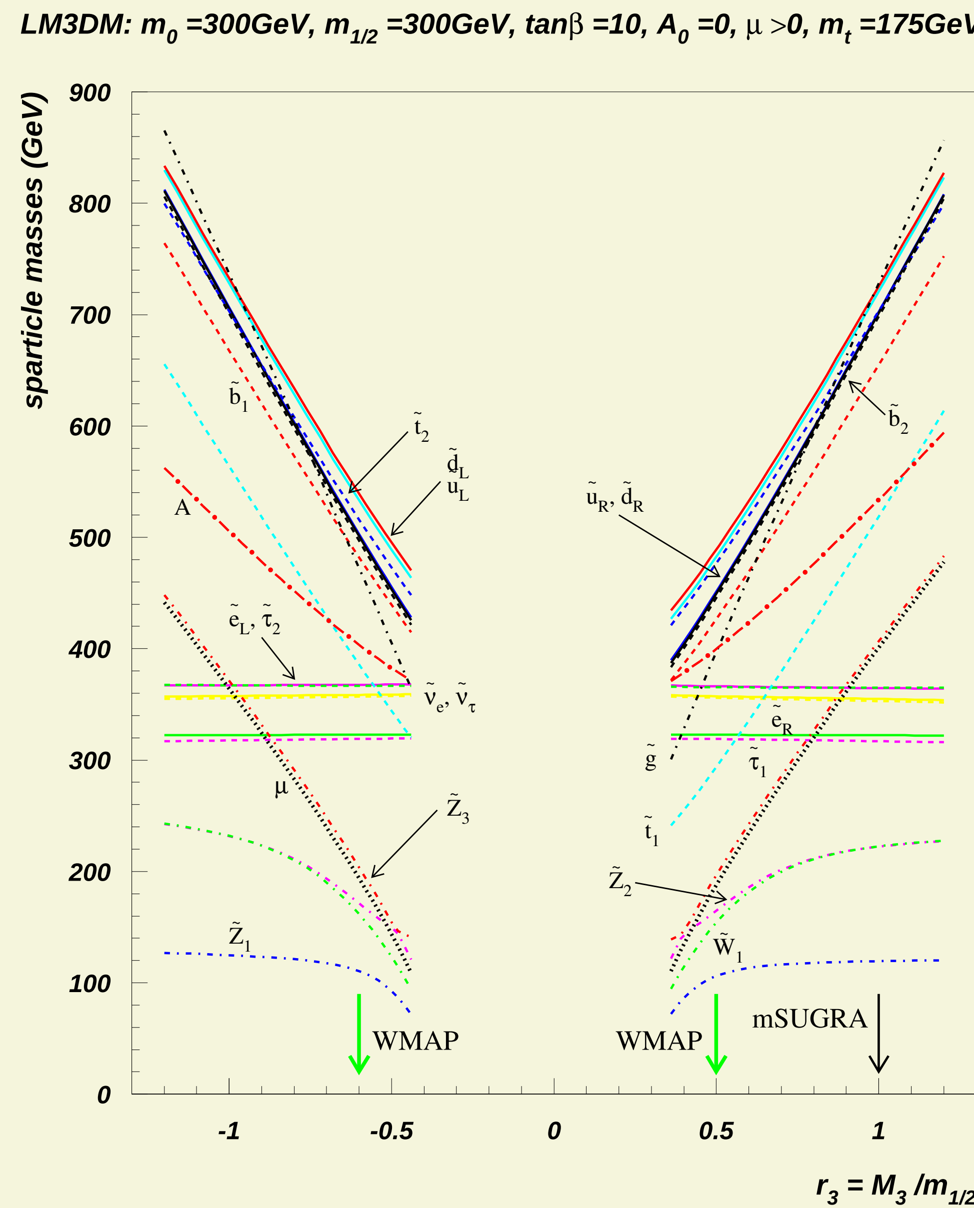
$\Longrightarrow$ Adopt independent gaugino masses at GUT scale

- M_1 *or* $M_2 \neq m_{1/2}$ – MWDM and BWCA scenarios
- $|M_3| \ll M_1 \simeq M_2$

Also Belanger *et al* (2005), Mambrini and Nezri (2005), Martin (2007

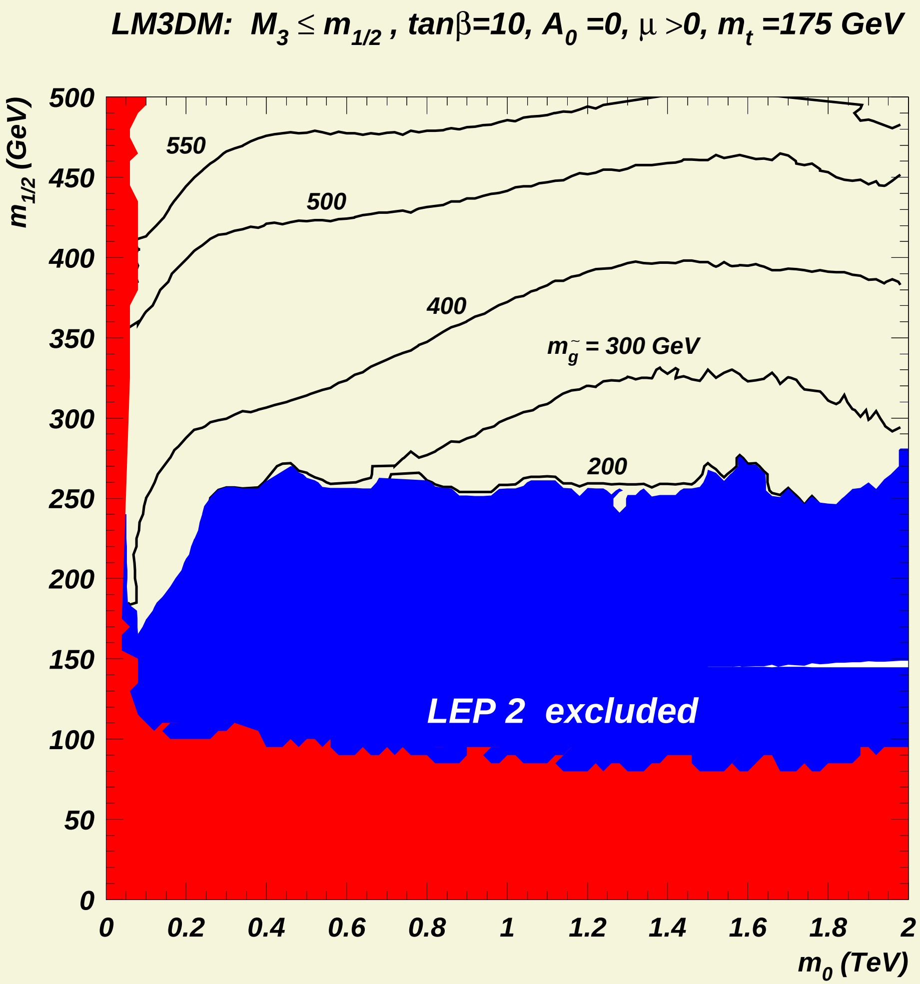
Sparticle mass spectrum

- Mass scale of squarks and sleptons less hierarchical
  - compressed SUSY
- Lighter gluino
- Very light stop
- Small $M_3 \rightarrow$ smaller $m_{\tilde{q}} \rightarrow$ small $|\mu|$
  - ▶ $\widetilde{Z}_1$ is mixed bino-higgsino
  - ▶ Small $\widetilde{Z}_2 - \widetilde{Z}_1$ and $\widetilde{W}_1 - \widetilde{Z}_1$ mass gaps (~ 50 GeV)



Parameter space

- By lowering M_3 any point in para space can be WMAP allowed
- Lighter gluinos expected in LM3DM $\rightarrow$ larger pair production
  e.g. $m_{\tilde{g}} \simeq 183$ GeV for
  $m_{1/2} = 250$ GeV
  $\sigma(p\bar{p} \rightarrow \tilde{g}\tilde{g}) \simeq 20$ pb
  (in mSUGRA $m_{\tilde{g}} \simeq 400$GeV and
  $\sigma(p\bar{p} \rightarrow \tilde{g}\tilde{g}) \simeq 30$ fb)
- Heavy squarks at large m_0 and large higgsino component
  $\rightarrow \tilde{g} \rightarrow q\bar{q}\widetilde{Z}_i$ suppressed
  $\rightarrow \tilde{g} \rightarrow g\widetilde{Z}_i$ dominate



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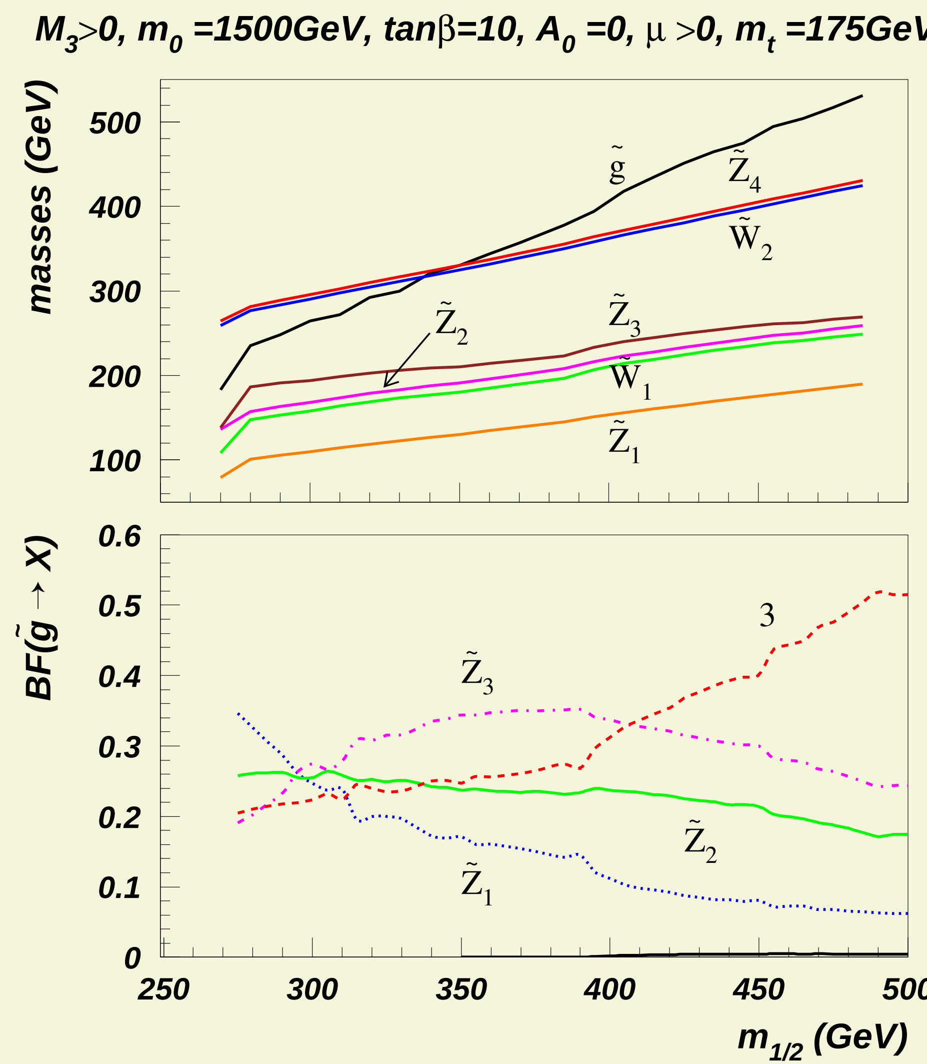

Search in $jets + E_T^{miss}$ channel

- $p\bar{p} \rightarrow \tilde{g}\tilde{g}$, $\tilde{g} \rightarrow g\widetilde{Z}_i$
- Backgrounds:
  $t\bar{t},\ W + jets,\ Z + jets$

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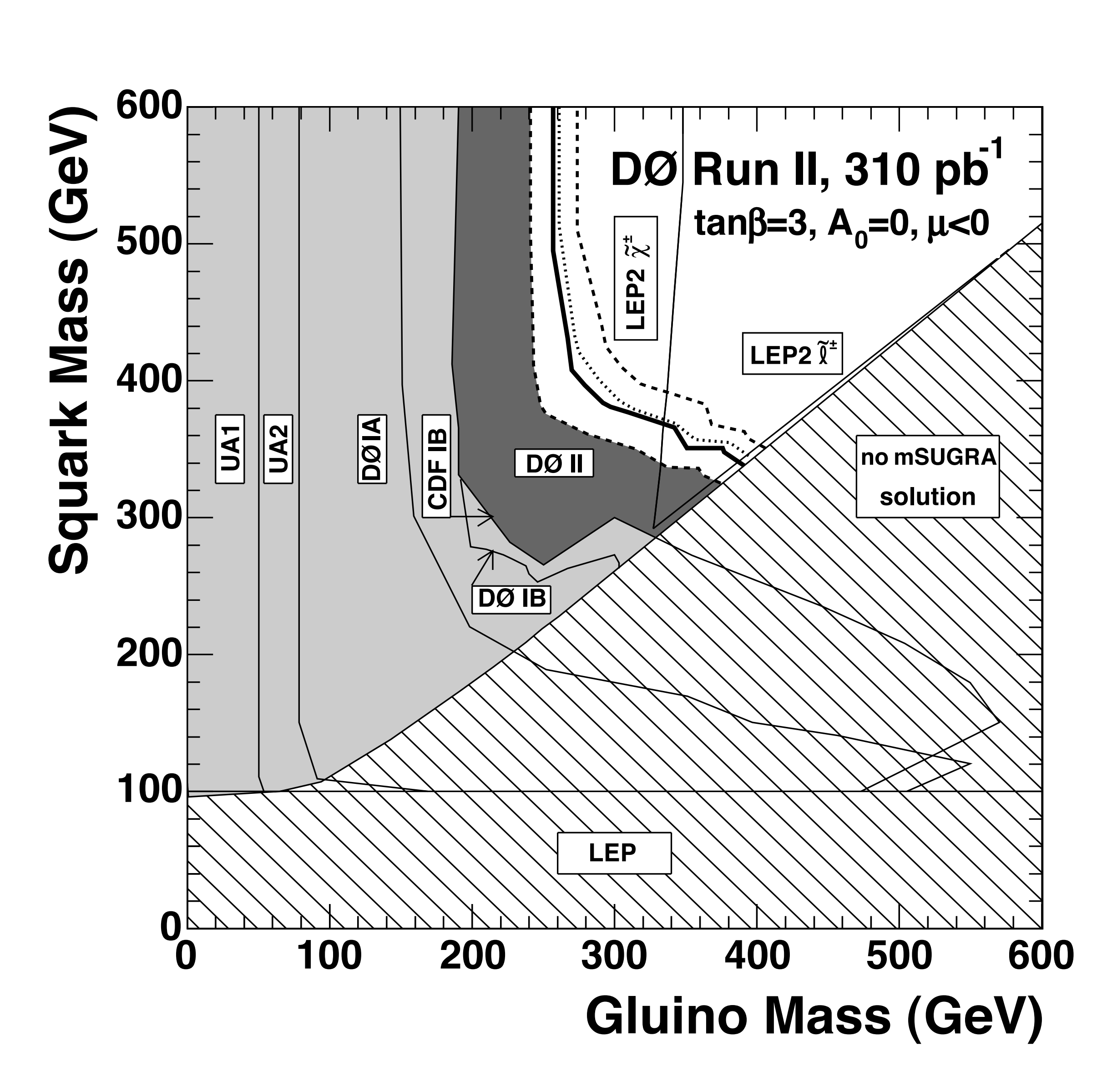
- $p\bar{p} \to \tilde{g}\tilde{g}$, $\tilde{g} \to g\widetilde{Z}_i$
- Backgrounds:
  $t\bar{t}$, $W + jets$, $Z + jets$
- Run I: $m_{\tilde{g}} > 200$ GeV
  D0 Run II: $m_{\tilde{g}} \geq 233$ GeV
- mSUGRA: $m_{\tilde{g}} \sim 3.5\ m_{\widetilde{W}_1}$



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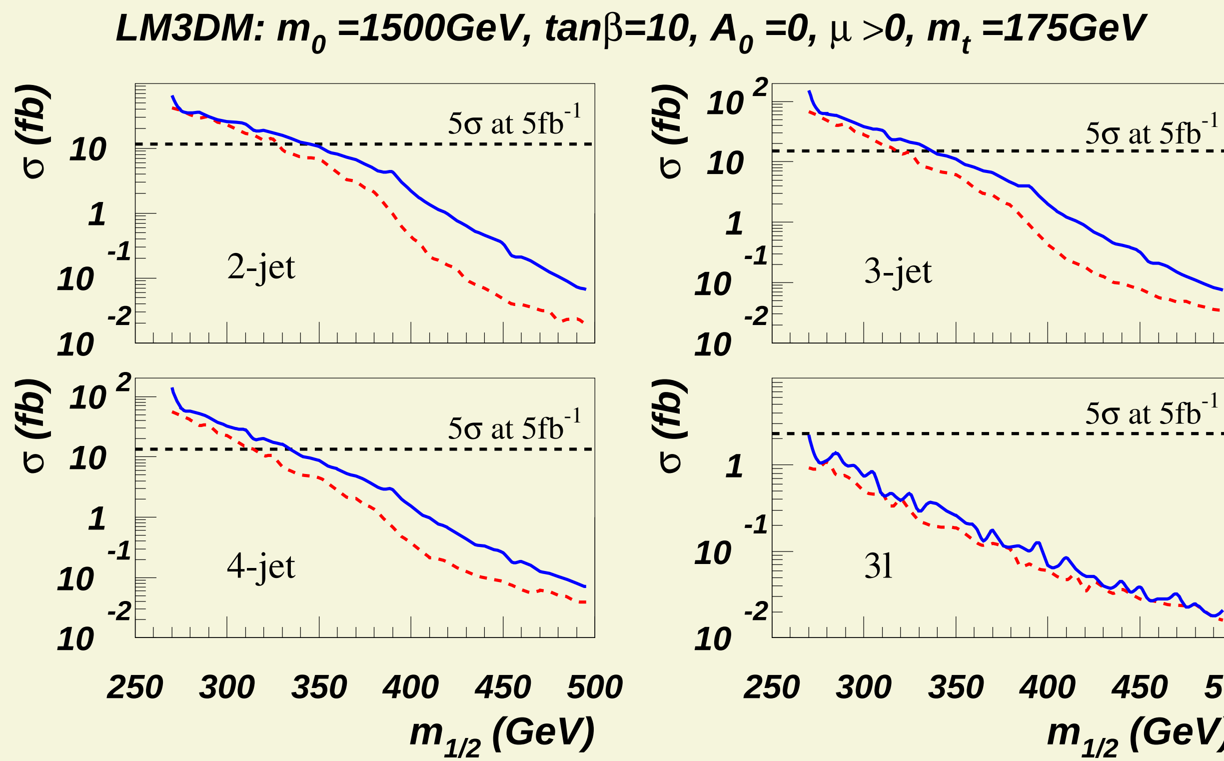
- LM3DM: $m_{\tilde{g}} \sim 1.7\ m_{\widetilde{W}_1}$
- Reach: $m_{\tilde{g}} \sim 320$ GeV
  ($m_{\widetilde{W}_1} \sim 170$ GeV)

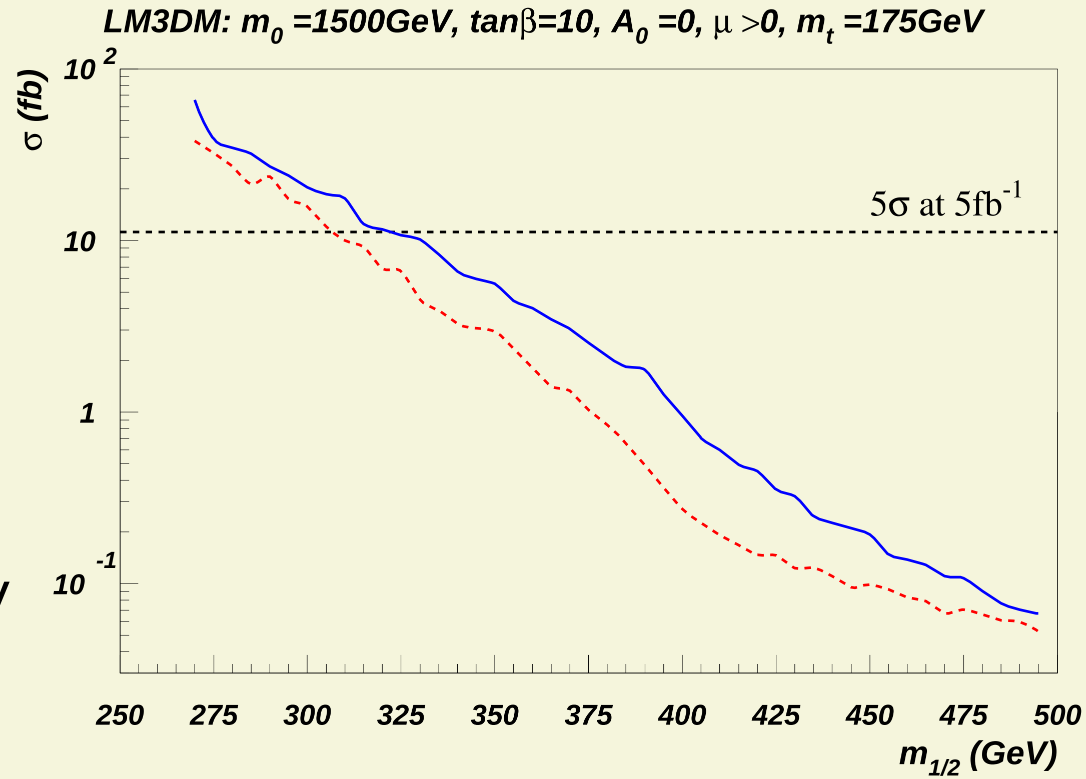


$jets + dilepton + E_T^{miss}$ channel

- $p\bar{p} \rightarrow \tilde{g}\tilde{g}$, $\tilde{g} \rightarrow g\widetilde{Z}_i$
  $\widetilde{Z}_i \rightarrow \widetilde{Z}_1 l\bar{l}$

$jets + dilepton + E_T^{miss}$ **channel**

- $p\bar{p} \to \tilde{g}\tilde{g}$, $\tilde{g} \to g\widetilde{Z}_i$
  $\widetilde{Z}_i \to \widetilde{Z}_1 l\bar{l}$
- Bkgd ($25\ fb$):
  $t\bar{t},\ Z + jets,\ WW,\ WZ,\ ZZ$
- Cuts: $E_T^{miss} > 75$ GeV
  b veto (50%)
  ≥ 2 central jets
  2 OS/SF leptons
- Reach to $m_{1/2} \sim 310 - 320$ GeV



$jets + dilepton + E_T^{miss}$ channel

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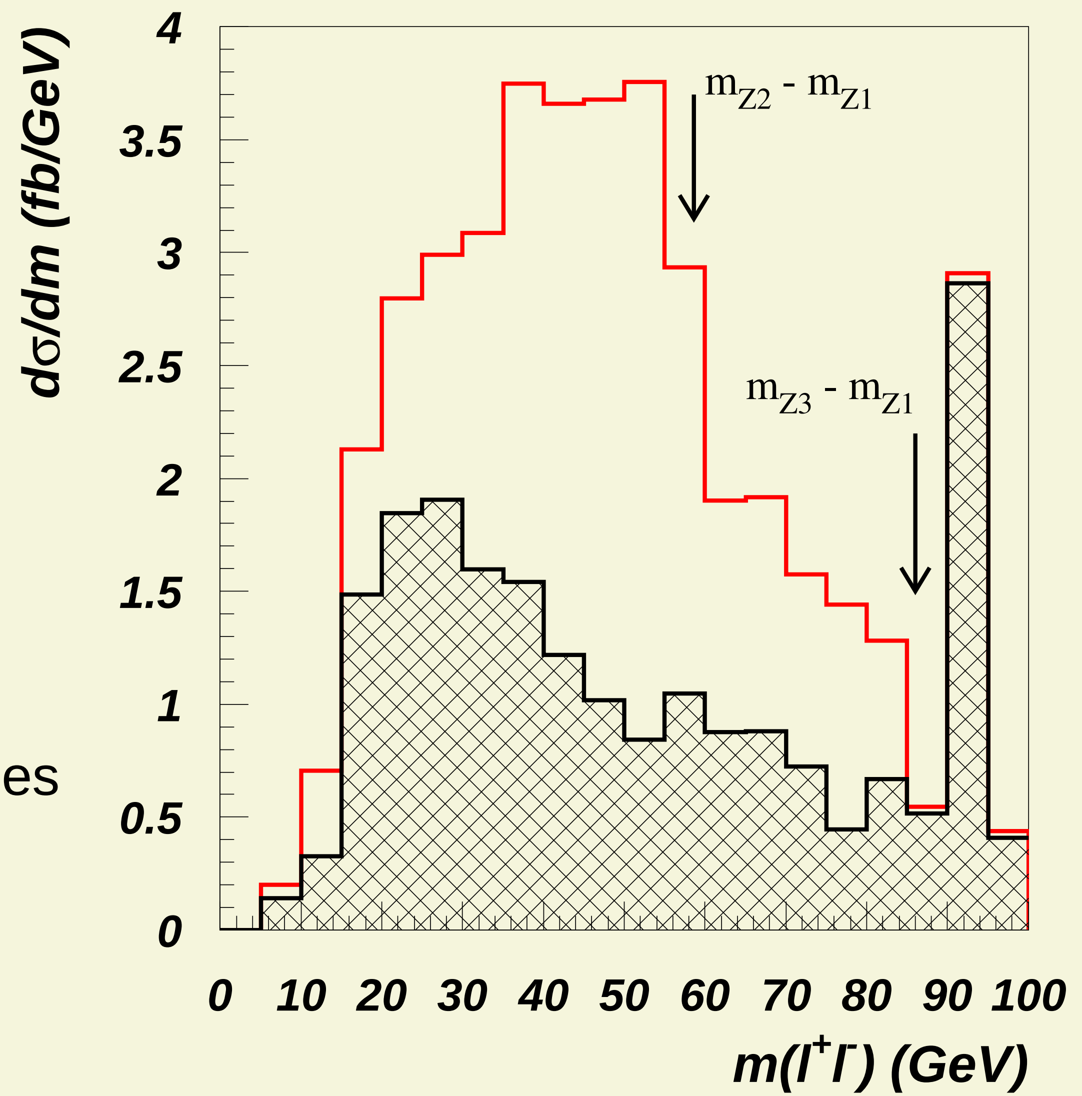
- Detectable $m_{\widetilde{Z}_i} - m_{\widetilde{Z}_1}$ mass edges



Conclusions

- Reducing $|M_3|$ allows $\widetilde{Z}_1$ relic density consistent with WMAP in almost any point of para space
- Bino-higgsino $\widetilde{Z}_1$ enhances DM detection prospects
- Compressed spectrum with lighter squarks and gluino
- Tevatron search in $jets + E_T^{miss}$ channel with $5\ fb^{-1}$ can probe up to $m_{1/2} = 350$ GeV which corresponds to $m_{\tilde{g}} \sim 320$ GeV and $m_{\widetilde{W}_1} \sim 170$ GeV
- Small μ makes $\widetilde{Z}_2$ and $\widetilde{Z}_3$ accessible via gluino decays - observable mass edges in Tevatron search in $jets + dilepton + E_T^{miss}$ channel

Cuts for $jets + E_T^{miss}$

cut	$2j + E_T^{miss}$	$3j + E_T^{miss}$	$4j + E_T^{miss}$
$\Delta\phi(j_1, j_2)$	$< 165°$	$< 165°$	$< 165°$
isol. lep. veto	yes	yes	yes
n_j	≥ 2	≥ 3	≥ 4
$\lvert\eta_{j_i}\rvert < 0.8$	j_1, j_2	j_1, j_2, j_3	j_1, j_2, j_3, j_4
$\Delta\phi(E_T^{miss}, j_1)$	$80° - 150°$	$80° - 150°$	$80° - 150°$
$\Delta\phi(E_T^{miss}, j_2)$	$50° - 150°$	$50° - 150°$	$60° - 150°$
E_T^{miss}	≥ 120 GeV	≥ 100 GeV	≥ 75 GeV
	≥ 175 GeV	≥ 100 GeV	≥ 75 GeV
H_T	≥ 220 GeV	≥ 150 GeV	—
	≥ 275 GeV	≥ 350 GeV	≥ 225 GeV
$E_T(jets)$	$\cdots$	$\cdots$	$\cdots$

Effect of $\tan\beta$