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SUSY02, June 17-23, 2002, DESY Hamburg, Germany

$B_s \to \mu^+\mu^-$ and Trilepton Events at the Tevatron

In collaboration with:

H. Dreiner and U. Nierste, Phys. Rev. Lett. 87, 251804 (2001), hep-ph/0108037

and

H. Dreiner, U. Nierste, and P. Richardson, to appear

1. The decay $B_s \to \mu^+\mu^-$ in the MSSM
2. $B_s \to \mu^+\mu^-$ and its correlation with the Trilepton events at Run II, $(g-2)_\mu$ and Light Higgs Boson mass in the mSUGRA scenario.
3. Conclusions

See also SUSY02 talks by

J. Urban, R. Arnowitt, C. Kolda, C. Balazs, S. Baek, W. de Boer.

The Experimental Facts

√ LEP Higgs boson mass bound (preliminary)

$$M_h \geq 107(113) \ \text{GeV} \quad \sin^2(\beta - \alpha) \simeq 1 \tag{1}$$

√ The muon anomalous magnetic moment

$$-4.2 \times 10^{-10} \leq \delta a_\mu^{\text{SUSY}} \leq 41.3 \times 10^{-10} \quad @90\% \ \text{CL} \tag{2}$$

√ The CDF upper bound on B_s-meson decay to dimuons

$$\mathcal{B}(B_s \to \mu^+\mu^-) < 2.0 \times 10^{-6} \quad @90\% \ \text{CL} \tag{3}$$

√ $\mathcal{B}(b \to s\gamma)$

[!conservative bound!]

$$2.0 \times 10^{-4} \leq \mathcal{B}(b \to s\gamma) \leq 5.0 \times 10^{-4} \tag{4}$$

√ SUSY searches

$$\ldots\ldots, m_{\tilde{\chi}_1^\pm} \gtrsim 100 \ \text{GeV}, \ \ldots\ldots\ldots \tag{5}$$

$B_s \to \mu^+\mu^-$ vs. $\delta a_\mu^{\rm SUSY}$ in the MSSM

- $\delta a_\mu^{\rm SUSY}$ depends upon 7 parameters (T. Moroi)

$$\delta a_\mu^{\rm SUSY} = f(M_1\ ,\ M_2\ ,\ A_\mu\ ,\ \mu\ ,\ \tan\beta\ ,\ m_{\tilde{\mu}_L}\ ,\ m_{\tilde{\mu}_R})$$

- $\mathcal{B}(B_s \to \mu^+\mu^-)$ depends (mainly) upon 7 parameters

$$\mathcal{B}(B_s \to \mu^+\mu^-) = f(M_2\ ,\ A_t\ ,\ \mu\ ,\ \tan\beta\ ,\ M_A\ ,\ m_{\tilde{t}_L}\ ,\ m_{\tilde{t}_R})$$

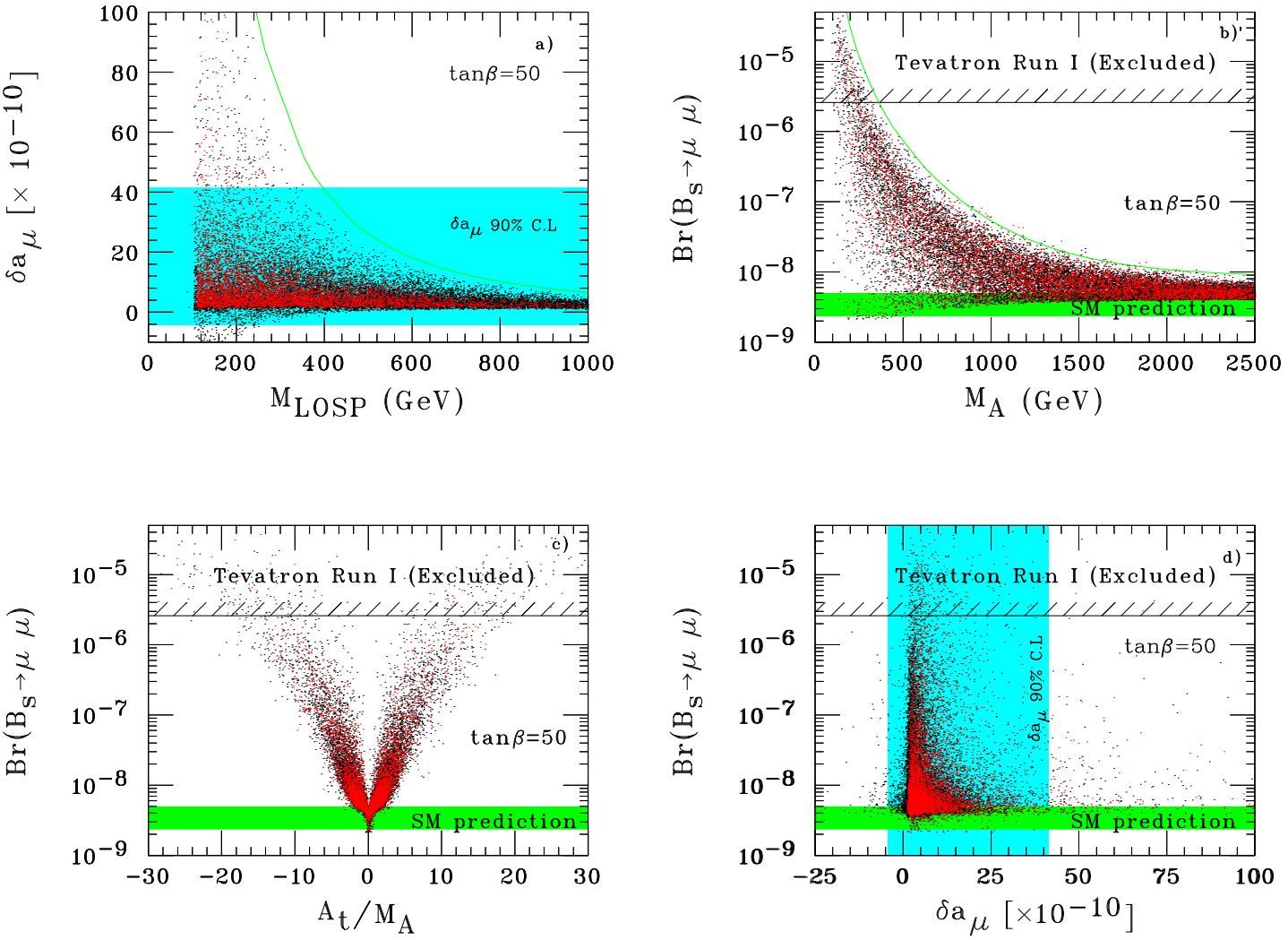
- Approximately :

$$\mathcal{B}(B_s \to \mu^+\mu^-) \simeq 3 \times 10^{-7} [\frac{m_\mu M_{B_s}}{M_W^2}]^2\ \frac{\tan^6\beta}{M_A^4} \mu^2 A_t^2\ C(m_{\tilde{t}}, m_{\tilde{\chi}})\ ,$$

MSSM : K. S. Babu and C. Kolda, '99,
C. Huang, W. Liao and Q. Yan, '99
P. H. Chankowski and L. Slawianowska, '01,
C. Bobeth, T. Ewerth, F. Kruger and J. Urban, '01, '02
G. Isidori, A. Retico, '01,
C. Bobeth, A. J. Buras, F. Kruger and J. Urban, Dec. '01,

mSUGRA : A. Dedes, H. K. Dreiner and U. Nierste, '01
R. Arnowitt, B. Dutta, T. Kamon and M. Tanaka, '02
H. Baer, C. Balazs, A. Belyaev, J. K. Mizukoshi, X. Tata and Y. Wang,'02

GMSB, AMSB : S. w. Baek, P. Ko and W. Y. Song, '02



- The Maximum mass for the Lightest Observable SUSY particle (LOSP) [Feng and Matchev '01]

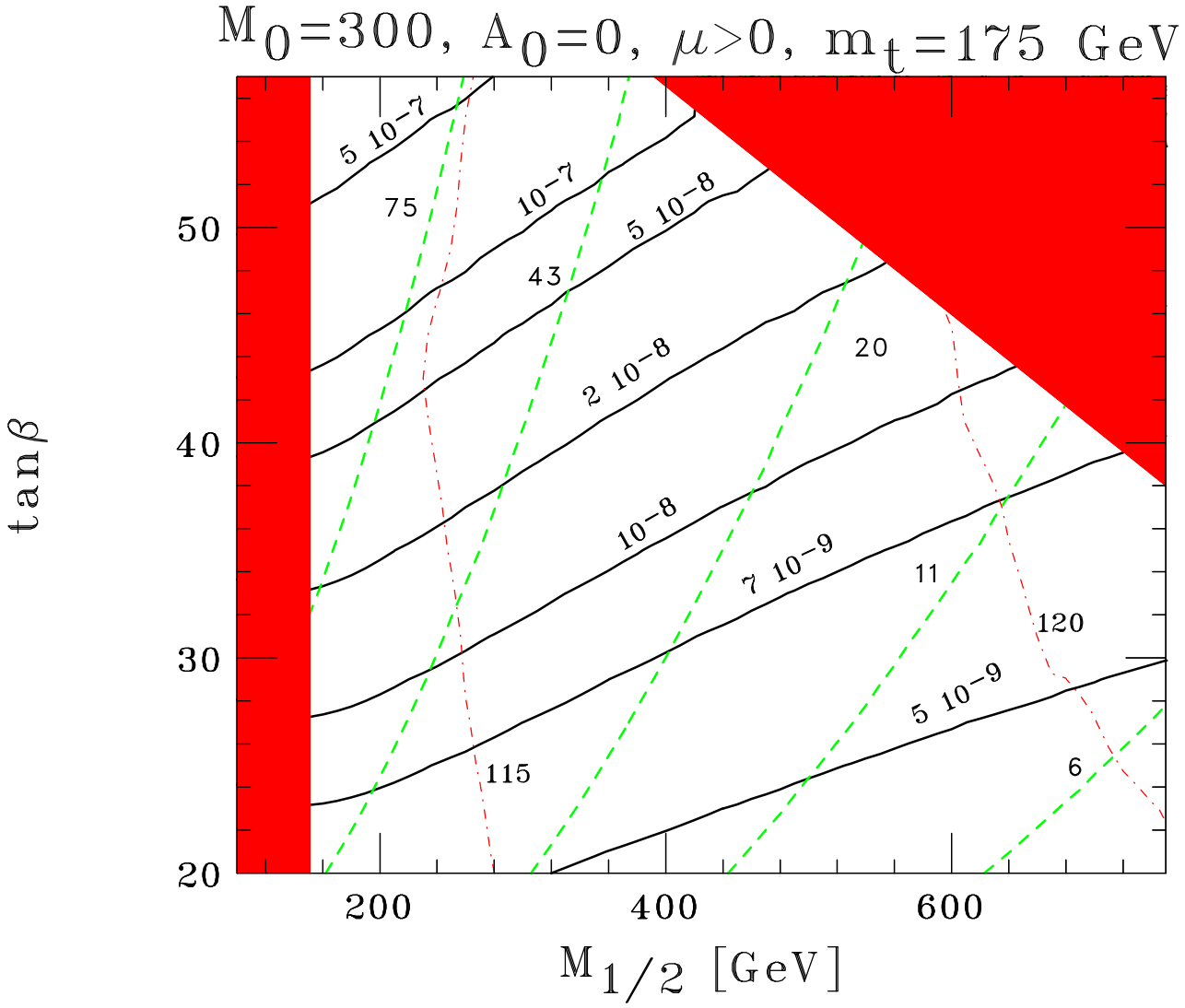
$$\delta a_\mu^{\rm SUSY} \simeq 18 \times 10^{-10} \frac{\tan\beta}{50} \left(\frac{603\ {\rm GeV}}{M_{\rm LOSP}^{\rm max}}\right)^2 ,$$

- The Maximum mass for the Heaviest Higgs Boson

$$\mathcal{B}(B_s \to \mu^+\mu^-) \simeq 5 \times 10^{-7} \left(\frac{\tan\beta}{50}\right)^6 \left(\frac{550\ {\rm GeV}}{M_A^{\rm max}}\right)^4$$

$B_s \to \mu^+\mu^-$ vs. $(g-2)_\mu$ in mSUGRA

A. Dedes, H. K. Dreiner and U. Nierste, '01



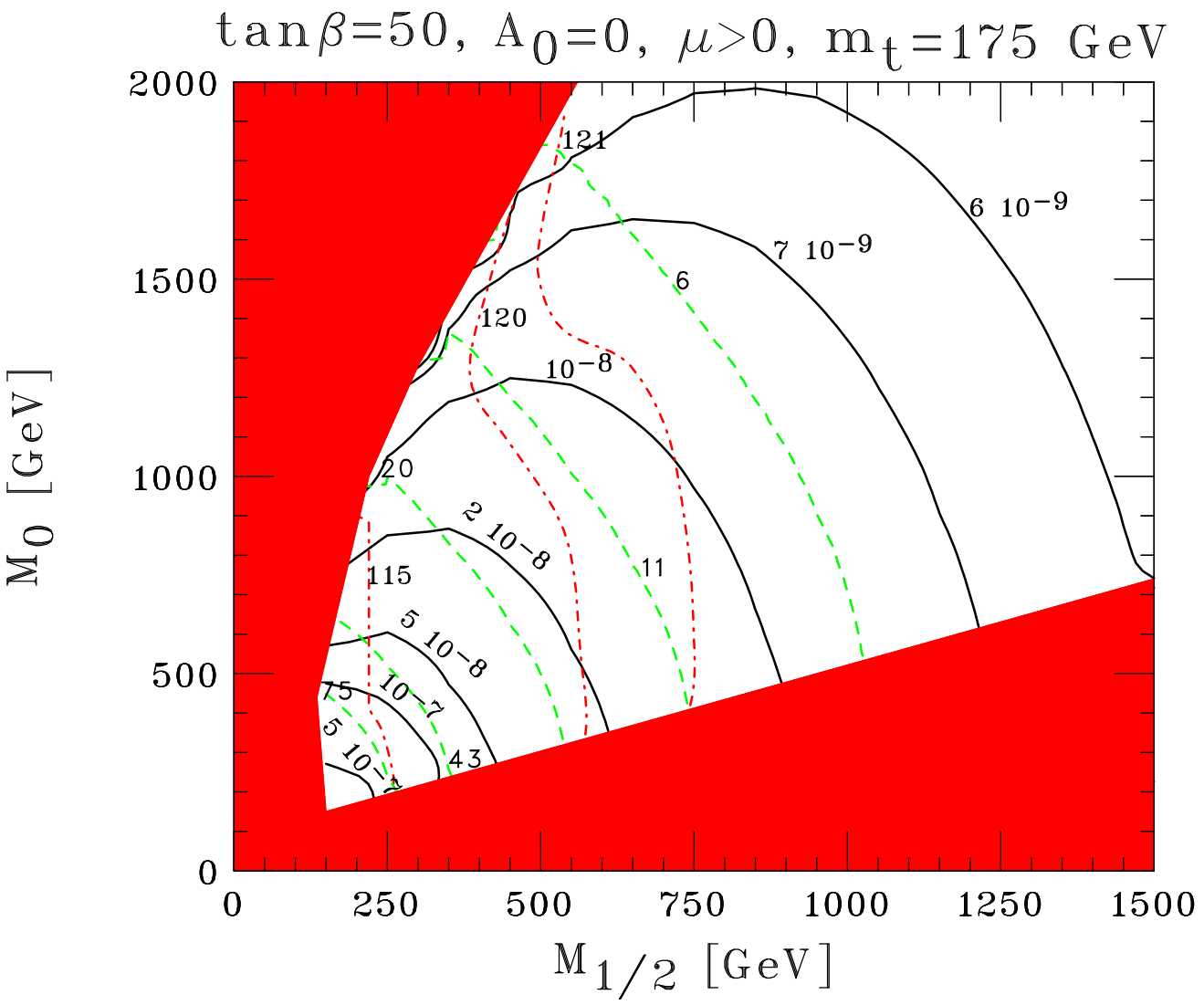
Solid : $\mathcal{B}(B_s \to \mu^+\mu^-)$

Dashed : $\delta a_\mu^{\rm SUSY}$ in 10^{-10} units

Dot-dashed : Higgs mass

Shaded : Excluded

A. Dedes, H. K. Dreiner and U. Nierste, '01



Solid : $\mathcal{B}(B_s \to \mu^+\mu^-)$

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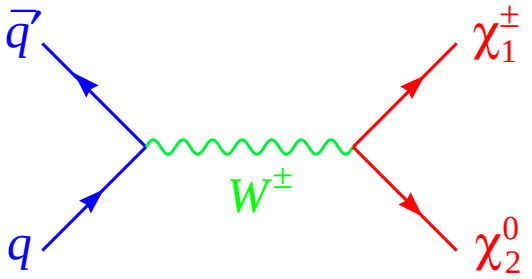
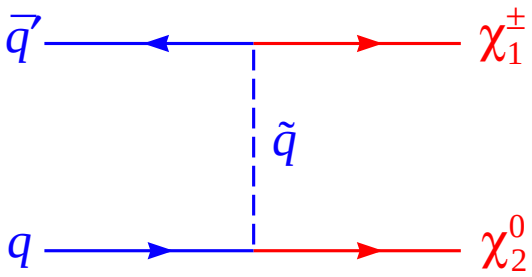
Trileptons and $B_s \to \mu^+\mu^-$ at Run II

- The "Gold-plated" Mode

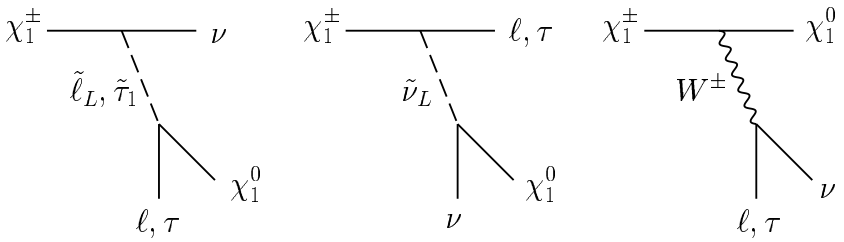
$$q\bar{q}' \to \chi_1^\pm \chi_2^0$$



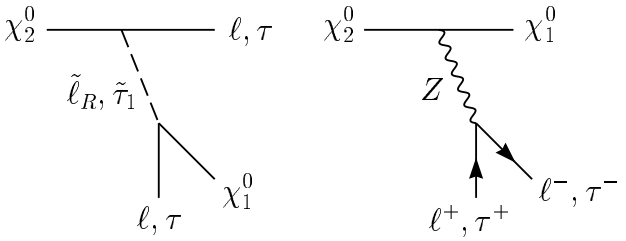
(a)



(b)



(a)



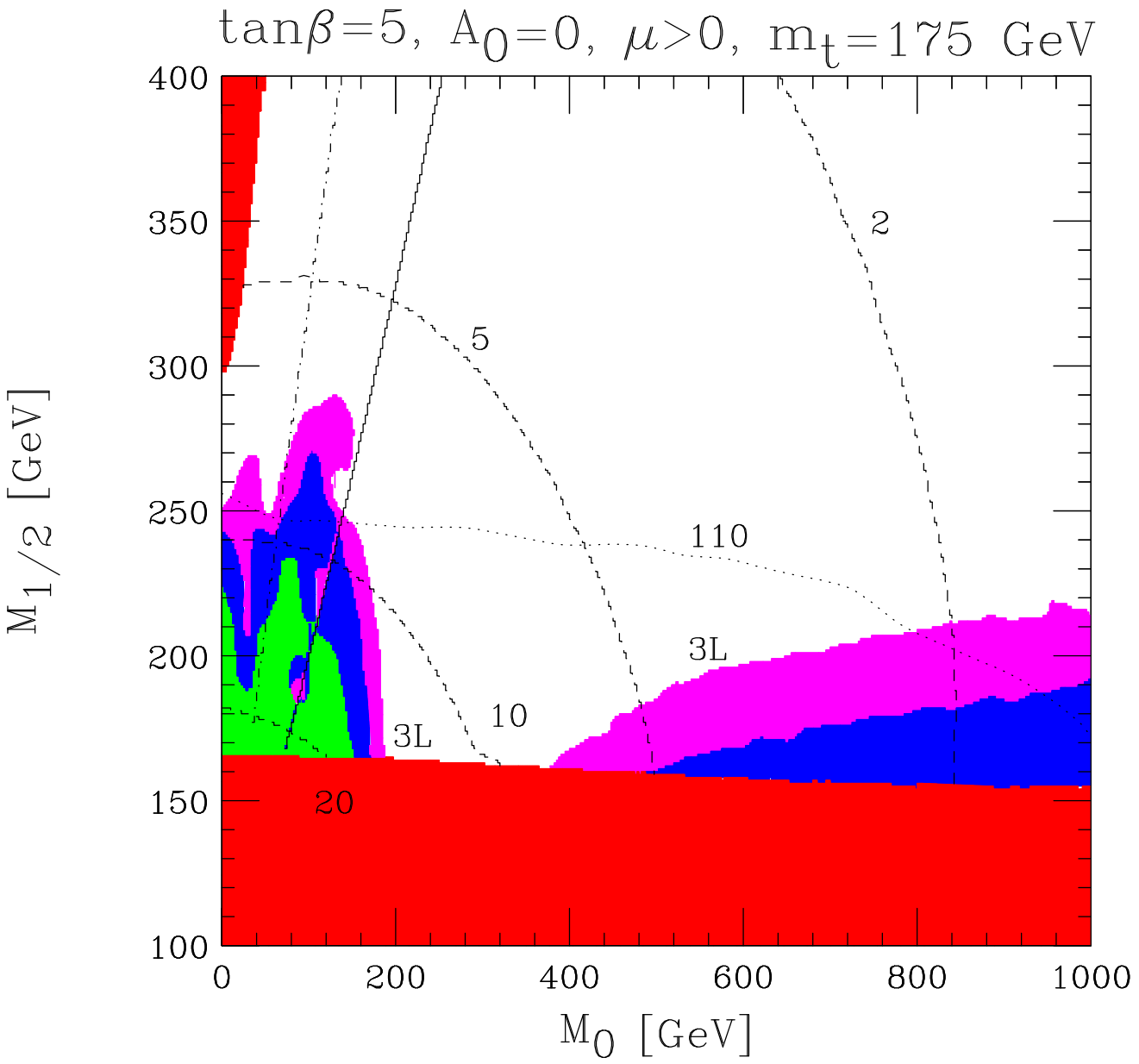
(b)

- Final State : lll, $l^\pm l^\pm$, $l^\pm l^\mp \tau$, $l^\pm \tau\tau$, $\tau\tau\tau$, $\tau^\pm \tau^\pm$

$l \equiv e, \mu$, focus on 3L $\equiv lll$

$\surd$ New and improved analysis compared to the one by Matchev and Pierce '99 $\to$ slightly bigger signal over the Background

A. Dedes, H. Dreiner, U. Nierste, P. Richardson '02



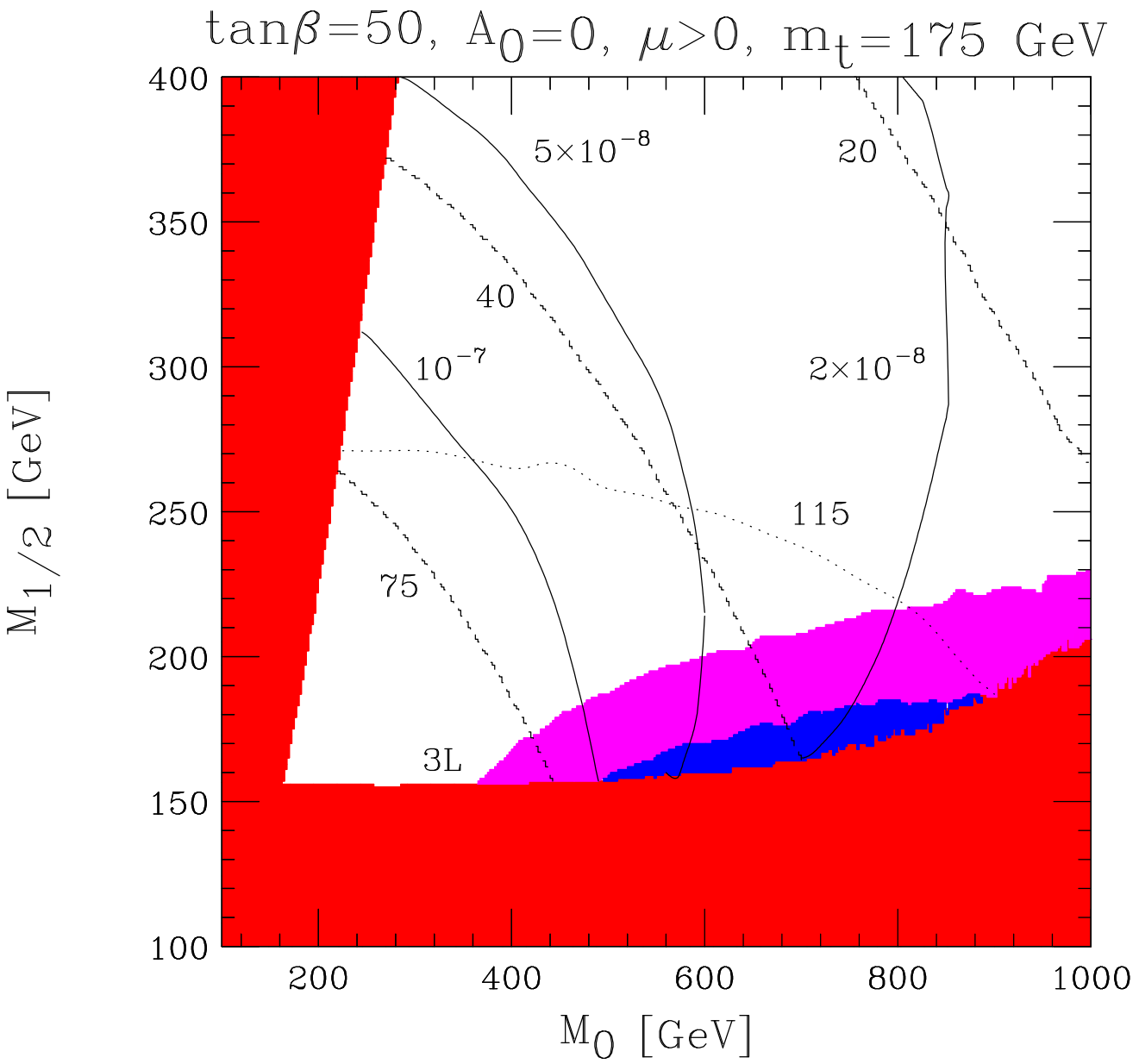
Tevatron 5σ reach for 3L and $\mathcal{L} = 2 fb^{-1}$

Tevatron 5σ reach for 3L and $\mathcal{L} = 10 fb^{-1}$

Tevatron 5σ reach for 3L and $\mathcal{L} = 30 fb^{-1}$

Dashed : $\delta a_\mu^{\rm SUSY}$ in 10^{-10} units

Dotted : Light Higgs Boson mass



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Tevatron 5σ reach for 3L and $\mathcal{L} = 30 fb^{-1}$

Solid : $\mathcal{B}(B_s \to \mu^+\mu^-)$

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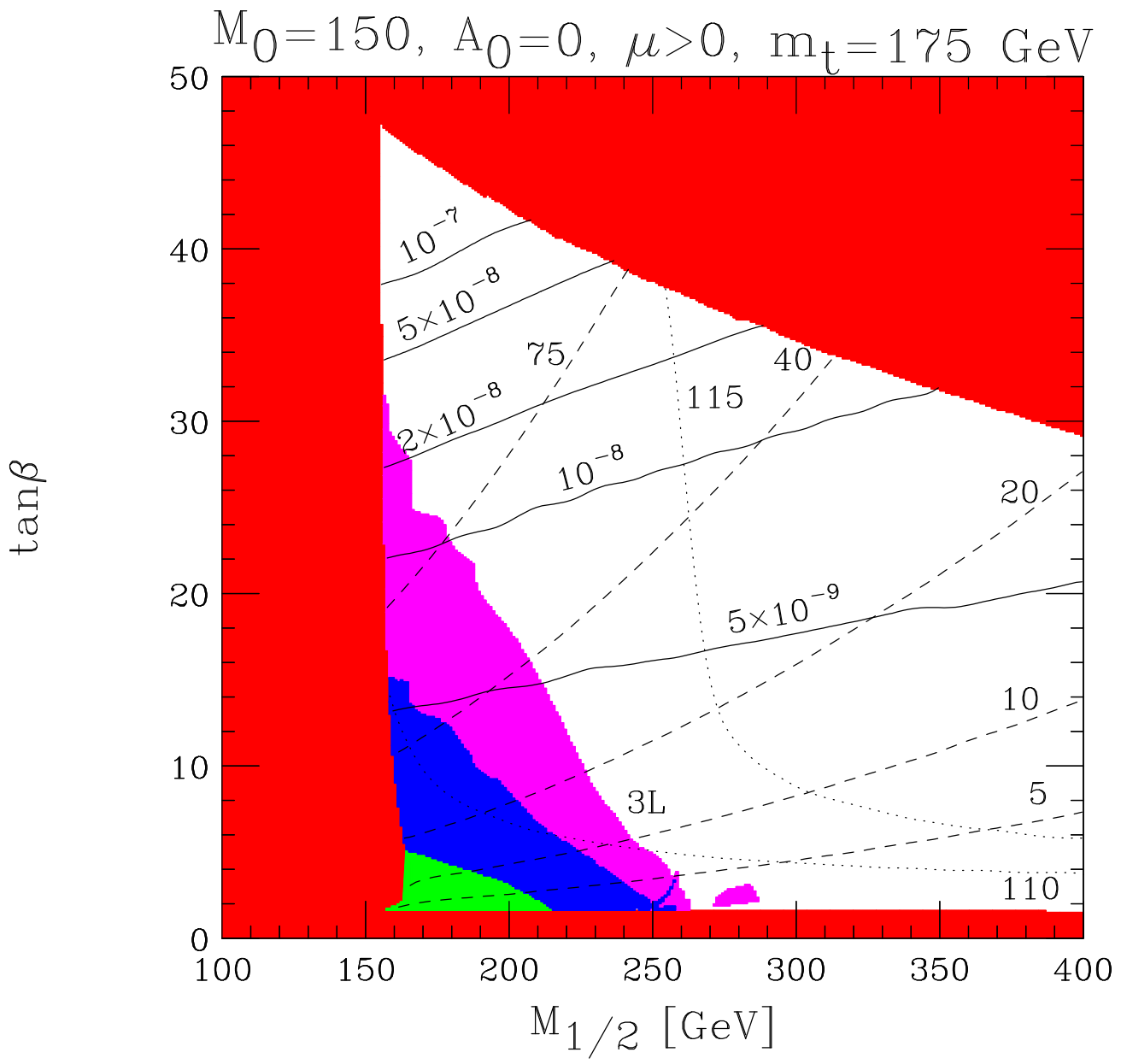

Tevatron 5σ reach for 3L and $\mathcal{L} = 2 fb^{-1}$

Tevatron 5σ reach for 3L and $\mathcal{L} = 10 fb^{-1}$

Tevatron 5σ reach for 3L and $\mathcal{L} = 30 fb^{-1}$

Solid : $\mathcal{B}(B_s \to \mu^+\mu^-)$

Dashed : $\delta a_\mu^{\rm SUSY}$ in 10^{-10} units

Dotted : Light Higgs Boson mass

Conclusions

$\surd$ If $B_s \to \mu^+\mu^-$ is observed at the Tevatron with $\mathcal{L} = 2fb^{-1}$ [$\mathcal{B}(B_s \to \mu^+\mu^-) \gtrsim 5 \times 10^{-7}$] then :

MSSM

- the heaviest Higgs boson mass is bounded from above in the MSSM, $M_A \lesssim 550$ GeV
- upper bound on the ratio A_t/M_A
- strong support for the minimal SUSY SO(10) model

mSUGRA

$\surd$ If $B_s \to \mu^+\mu^-$ is observed at the Tevatron Run II [$\mathcal{B}(B_s \to \mu^+\mu^-) \gtrsim 10^{-8}$] then :

- $\delta a_\mu^{\rm SUSY}$ deviates significantly from zero
- $m_h^{max} \lesssim 120$ GeV
- $B_s \to \mu^+\mu^-$ complements the trilepton searches
- a No-Lose scenario for mSUGRA at the Tevatron with $M_{1/2}$, $M_0 \lesssim 400$ and $\tan\beta \gtrsim 40$

`It might be that these are the SUSY footprints at Tevatron.....`