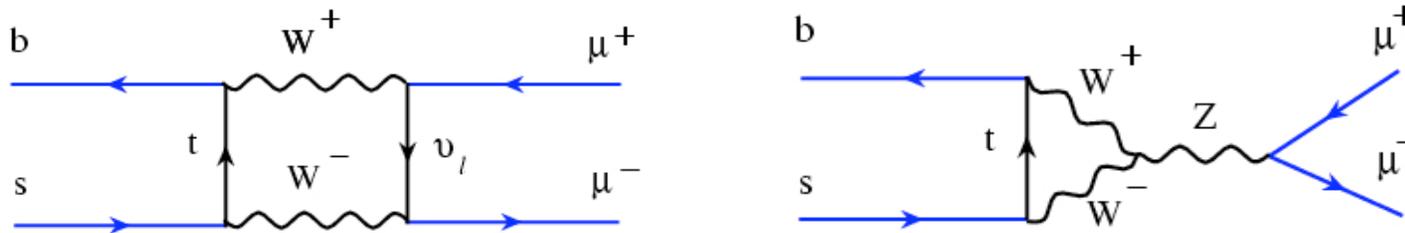


Introduction

- In the Standard Model, the FCNC decay of $B \rightarrow \mu^+ \mu^-$ is heavily suppressed



SM prediction $\rightarrow BR(B_s \rightarrow \mu^+ \mu^-) = (3.5 \pm 0.9) \times 10^{-9}$
(Buchalla & Buras, Misiak & Urban)

- $B_d \rightarrow \mu \mu$ is further suppressed by CKM coupling $(v_{td}/v_{ts})^2$
- SM prediction is below the sensitivity of current experiments (CDF+D0): **SM \rightarrow Expect to see 0 events at the Tevatron**

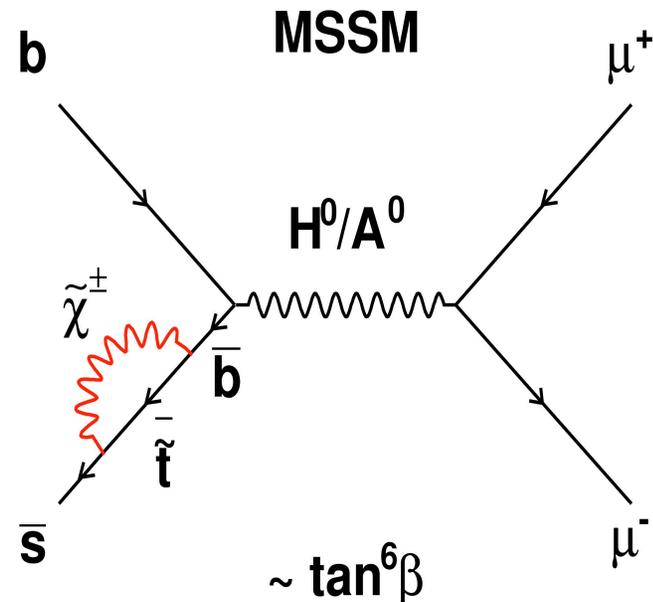
Any signal would indicate new physics!!

BEYOND STANDARD MODEL

- In many SUSY models, the BR could be enhanced by many orders of magnitude:

For example:

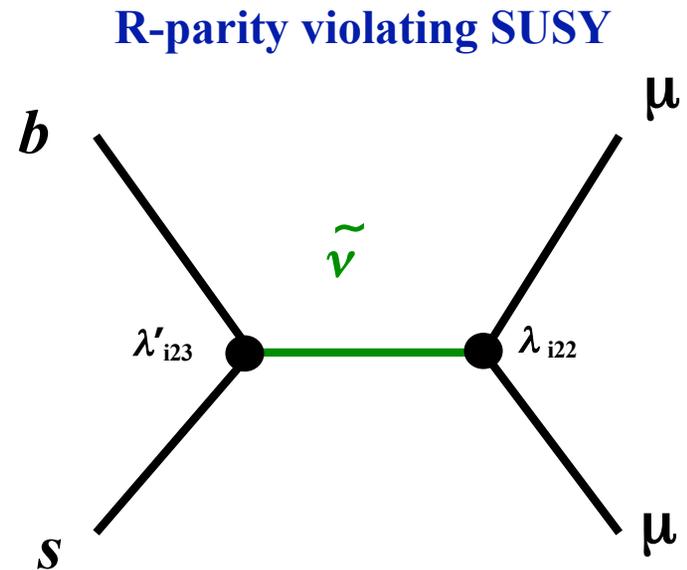
- MSSM: $\text{Br}(B \rightarrow \mu\mu)$ is proportional to $\tan^6\beta$
- $\text{Br}(B \rightarrow \mu\mu)$ also enhanced at high $\tan\beta$ in GUT SO(10) models
- BR could be as large as 10-1000 times the SM prediction



Would be observable at the Tevatron

BEYOND STANDARD MODEL

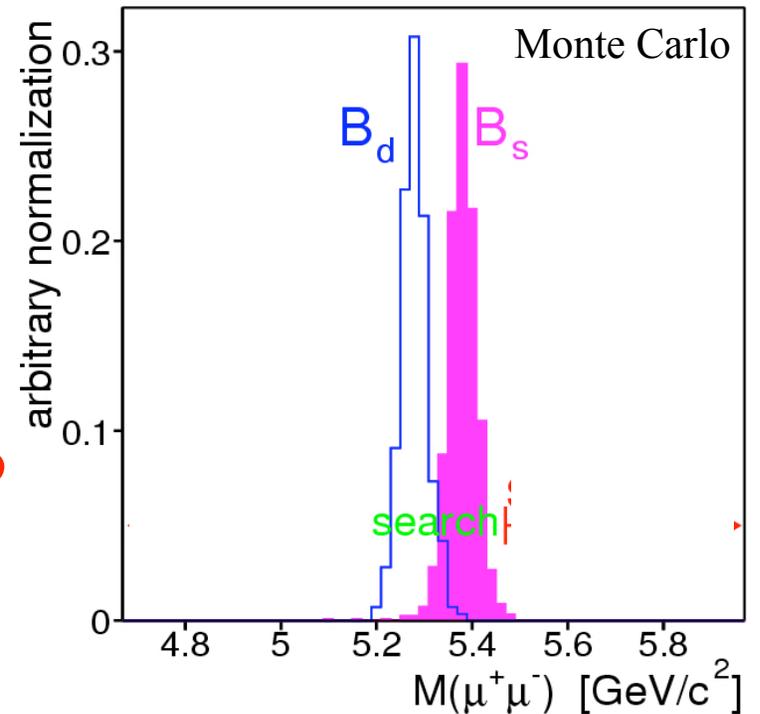
- Another example:
R-Parity violating SUSY
 - Tree level diagram is allowed in R-parity violating (RPV) SUSY models.
 - Possible to observe decay even for low value of $\tan\beta$
 - Enhancement depends strongly on coupling constants (λ , λ')



Would also be observable at the Tevatron

PROBE OF NEW PHYSICS

- New physics may enhance B_s and $B_d \rightarrow \mu\mu$ differently
- Minimal-flavor-violation (MFV) assumption in SUSY yields SM relations between B_s and $B_d \rightarrow \mu\mu$ decays
- Can observe both B_s and B_d : **unique to Tevatron**
- CDF has the mass resolution to distinguish two decays, $\sigma(M_{\mu\mu}) \sim 23\text{MeV}$: **unique to CDF**
- Either observation or null search, results will provide important clues about possible scenarios of new physics beyond SM



$$M(B_s) - M(B_d) \sim 90\text{MeV}$$

Limits Summary

Bs: we observed **0 events** which yields a combined limit of:

$$1.6 \cdot 10^{-7} @ 90\% \text{ CL}$$

$$2.1 \cdot 10^{-7} @ 95\% \text{ CL}$$

Bd: we observed **0 events** which yields a combined limit of:

$$3.9 \cdot 10^{-8} @ 90\% \text{ CL}$$

$$5.1 \cdot 10^{-8} @ 95\% \text{ CL}$$

$$\text{Br}(\text{Bs} \rightarrow \mu\mu) < 4.1 \cdot 10^{-7} @ 90\% \text{ CL} ; \text{ D0 PRL 94 (2005) 042001}$$

$$\text{Br}(\text{Bs} \rightarrow \mu\mu) < 5.8 \cdot 10^{-7} @ 90\% \text{ CL} ; \text{ CDF PRL 93 (2003) 032001}$$

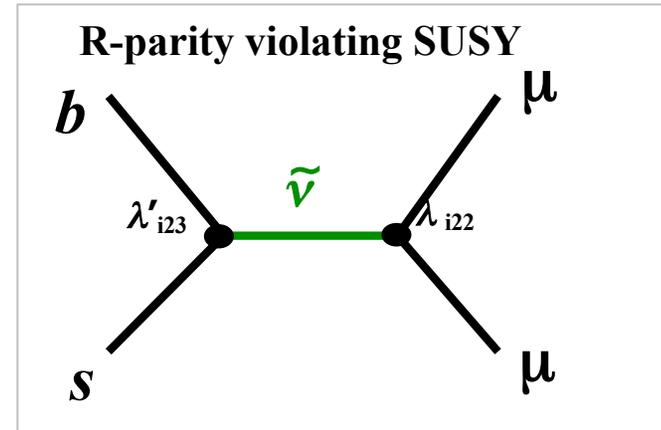
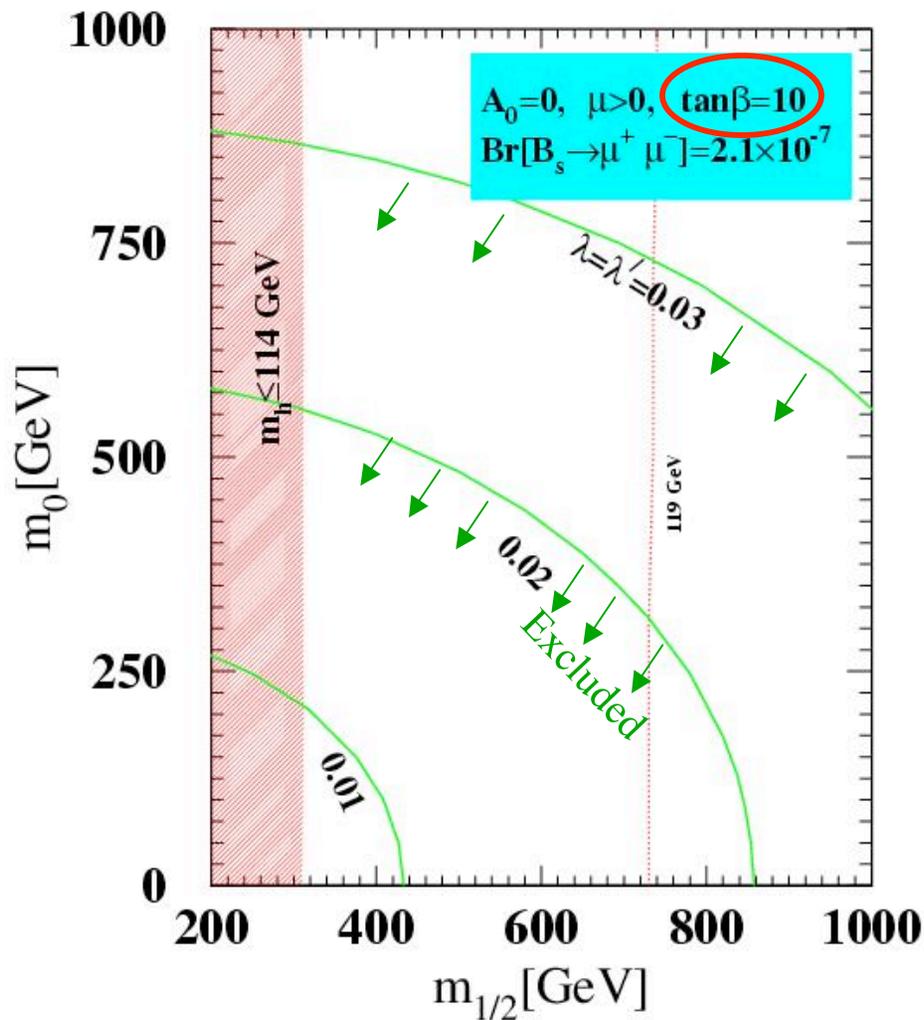
$$\text{Br}(\text{Bd} \rightarrow \mu\mu) < 3.0 \cdot 10^{-7} @ 90\% \text{ CL} ; \text{ D0 Preliminary 4733}$$

$$\text{Br}(\text{Bd} \rightarrow \mu\mu) < 8.0 \cdot 10^{-8} @ 90\% \text{ CL} ; \text{ (BaBar PRL 94 (2005) 221803)}$$

Both CDF Bs and Bd results are x2 better than the best published result!!!

RPV SUSY EXCLUSION

B. Dutta, U. Regina

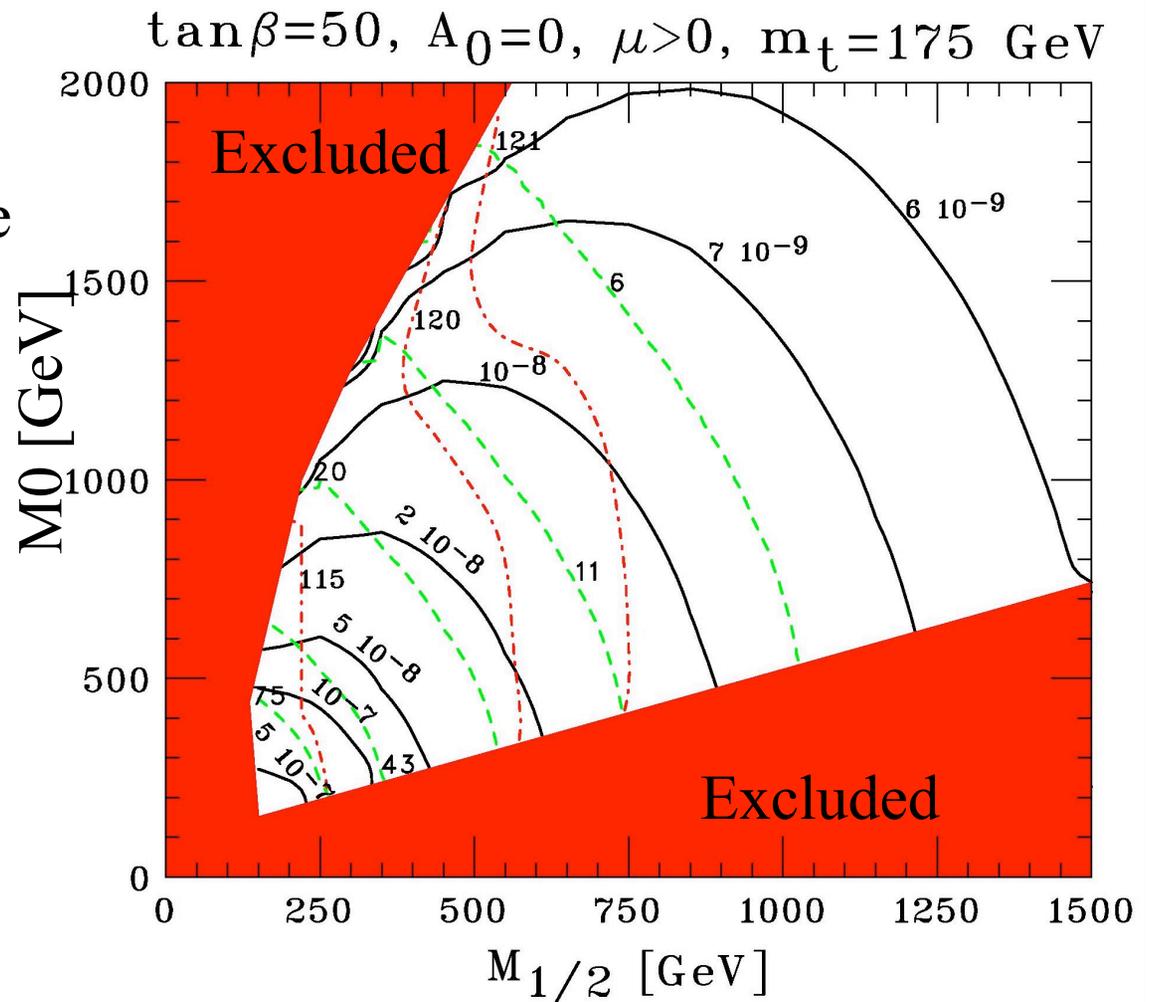


- Possible to exclude phase space even for small $\tan(\beta)$
- Exclusion strongly depends on the coupling.

mSUGRA M_0 vs $M_{1/2}$

Dedes, Dreiner, Nierste,
PRL 87(2001) 251804

- We are beginning to carve into mSUGRA space
- For $m_h \sim 115 \text{ GeV}$ implies $10^{-8} < \text{Br}(Bs \rightarrow \mu\mu) < 3 \cdot 10^{-7}$



Solid red = excluded by theory or experiment

Dashed red line = light Higgs mass (m_h)

Dashed green line = $(\delta a_\mu)_{\text{susy}}$ (in units of 10^{-10})

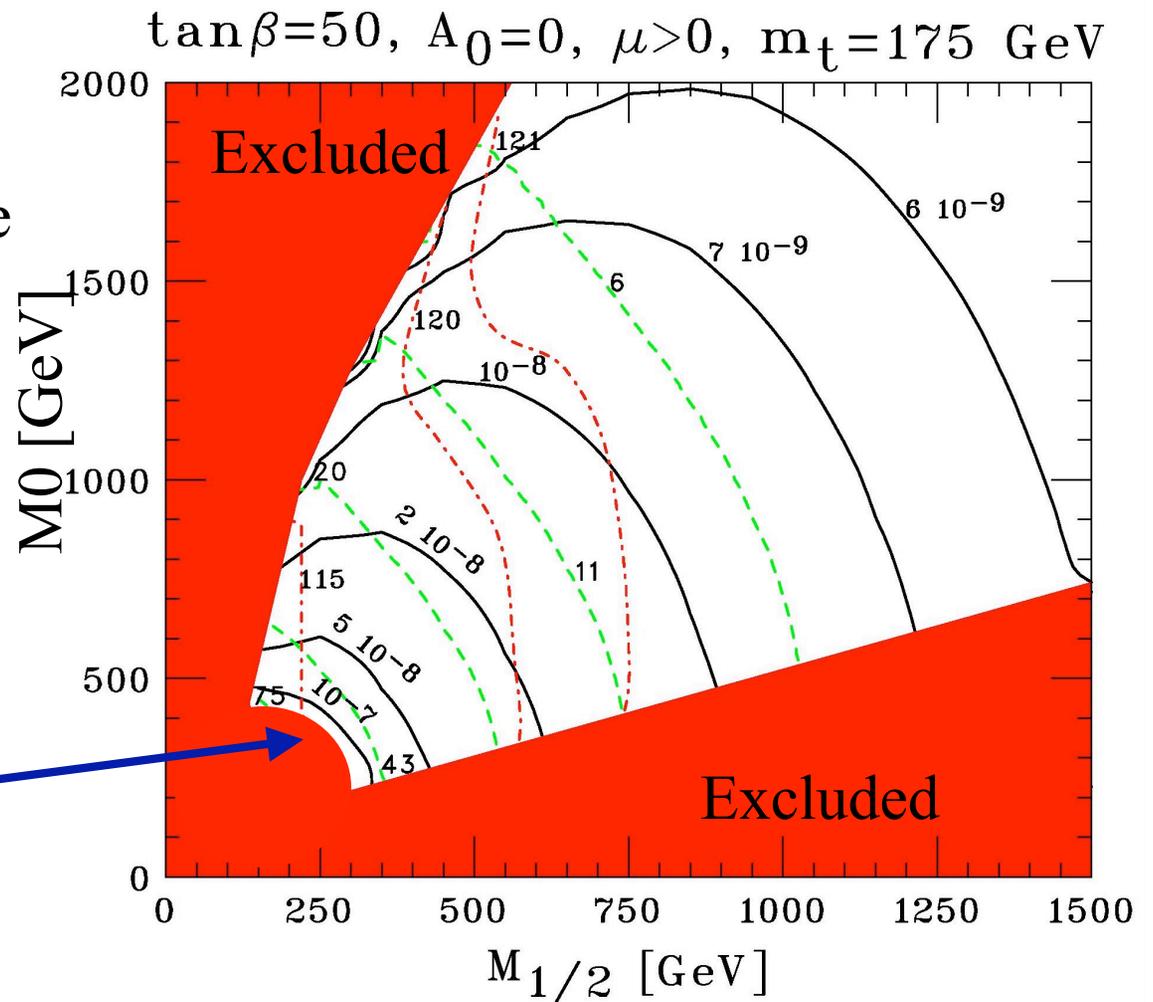
Black line = $\text{Br}(Bs \rightarrow \mu\mu)$

mSUGRA M_0 vs $M_{1/2}$

Dedes, Dreiner, Nierste,
PRL 87(2001) 251804

- We are beginning to carve into mSUGRA space
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Excluded by this new result



Solid red = excluded by theory or experiment

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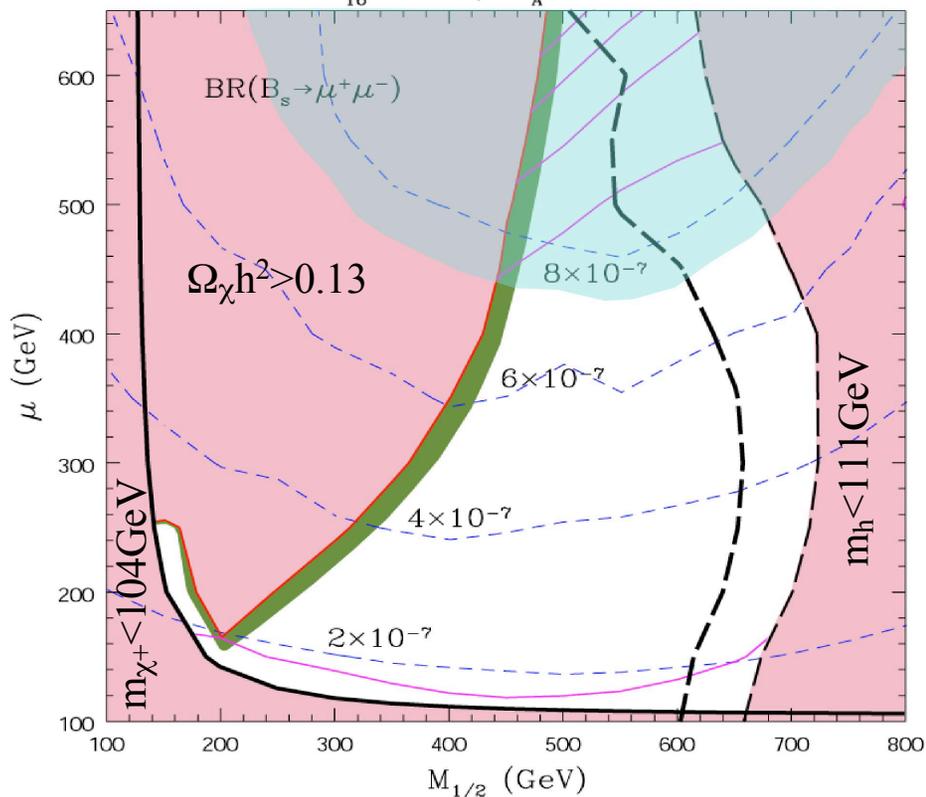
Dashed green line = $(\delta a_\mu)_{\text{susy}}$ (in units of 10^{-10})

Black line = $\text{Br}(Bs \rightarrow \mu\mu)$

SO(10) Unification Model

R. Dermisek *et al.*,
hep-ph/0304101

$m_{16}=3 \text{ TeV}$, $m_A=500 \text{ GeV}$



- $\tan(\beta) \sim 50$ constrained by unification of Yukawa coupling
- White region is not excluded
- Unification valid for small $M_{1/2}$ ($\sim 500 \text{ GeV}$)

Red regions are excluded by either theory or experiments

Green region is the WMAP preferred region

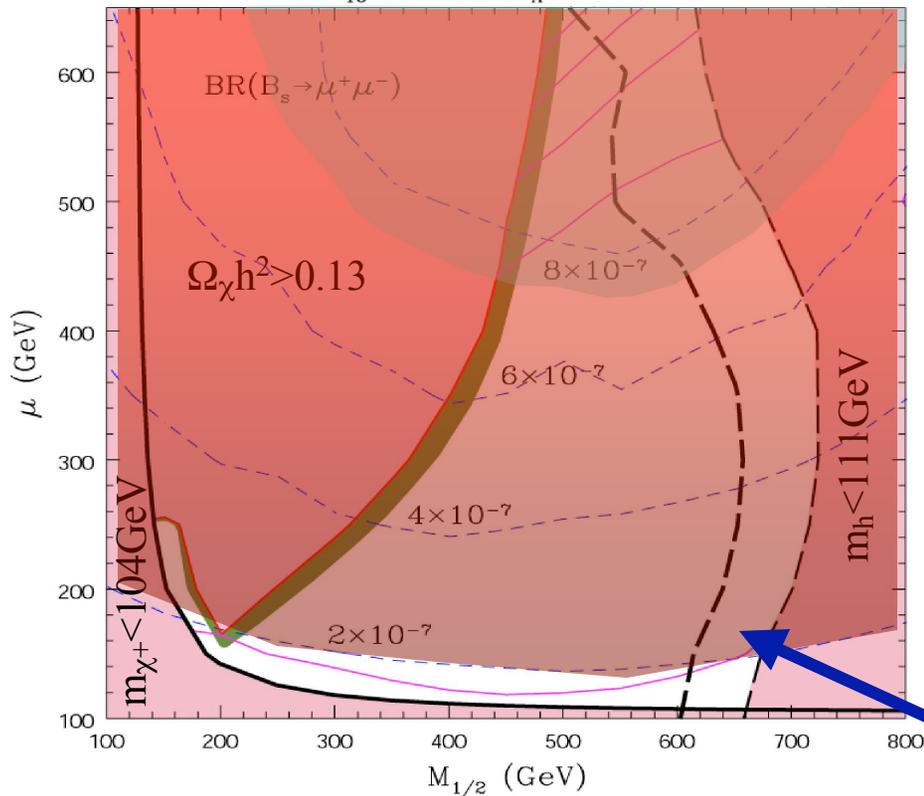
Blue dashed line is the $\text{Br}(B_s \rightarrow \mu\mu)$ contour

Light blue region excluded by old $B_s \rightarrow \mu\mu$ analysis

SO(10) Unification Model

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hep-ph/0304101

$m_{16}=3 \text{ TeV}$, $m_A=500 \text{ GeV}$



- $\tan(\beta) \sim 50$ constrained by unification of Yukawa coupling
- All previously allowed regions (white) are excluded by this new measurement
- Unification valid for small $M_{1/2}$ ($\sim 500 \text{ GeV}$)
- New $\text{Br}(B_s \rightarrow \mu\mu)$ limit strongly disfavors this solution for $m_A = 500 \text{ GeV}$

Red regions are excluded by either theory or experiments

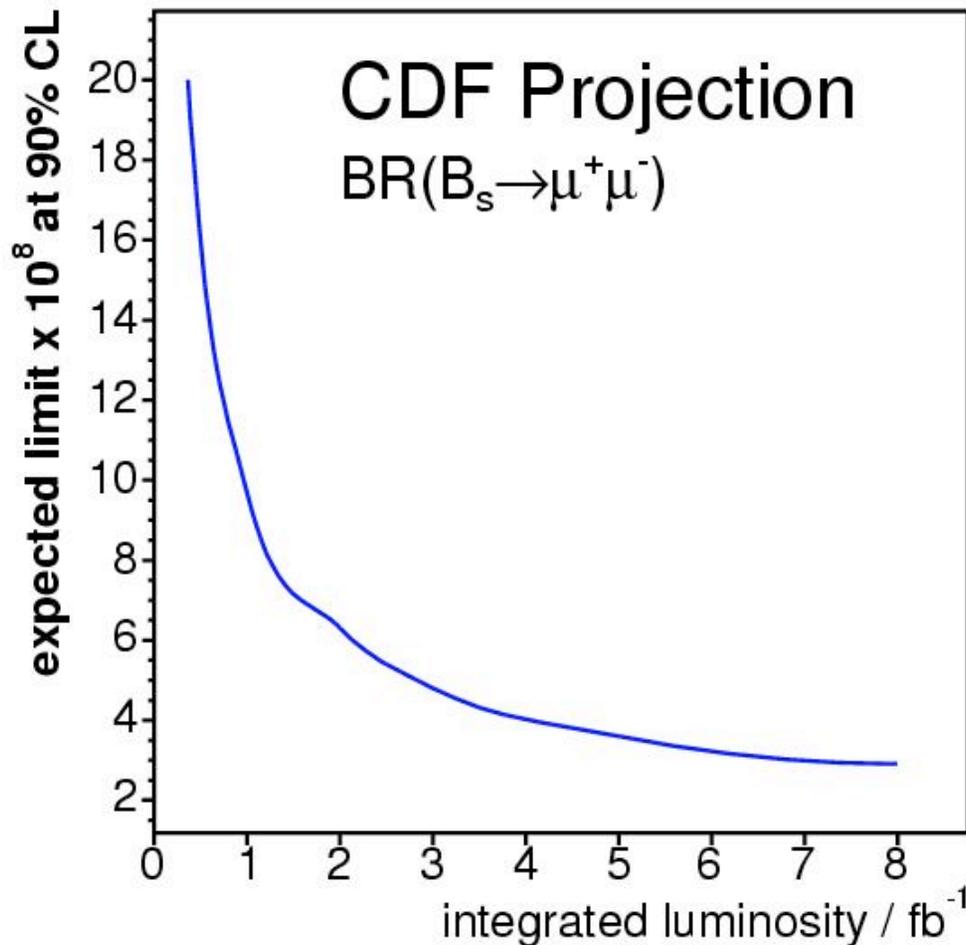
Green region is the WMAP preferred region

Blue dashed line is the $\text{Br}(B_s \rightarrow \mu\mu)$ contour

Light blue region excluded by old $B_s \rightarrow \mu\mu$ analysis

Excluded by this new result

$B_s \rightarrow \mu\mu$ Limit Projection



- Extrapolate based on the current analysis which was optimized for 1/fb
- Assume background scales linearly with luminosity
- Will need to re-optimize the analysis for $> 3/\text{fb}$