

CMSSM with Yukawa Quasi-Unification

Karagiannakis Nikos

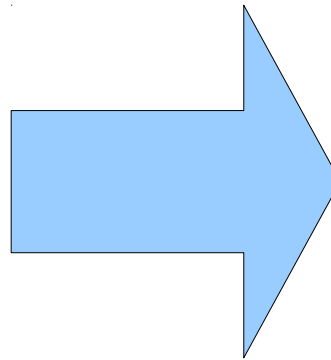
Physics Division
General Department
Polytechnic School
Aristotle University of Thessaloniki

Based on “CMSSM with Yukawa quasi-unification revisited” by N. Karagiannakis, G. Lazarides, C. Pallis (Physics Letters B in press and also in arXiv:1107.0667 [hep-ph])

From CMSSM to ... CMSSM with 'asymptotic' Yukawa quasi-Unification

CMSSM

**Contains MSSM
UBC**

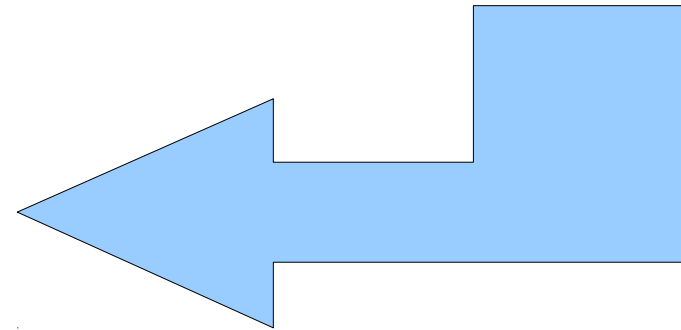


CMSSM with 'asymptotic' YU

**SUSY GUT gauge group (PS)
More restrictions
 h_t, h_b, h_τ unification
Problems with m_b**

CMSSM with 'asymptotic' quasi-YU

**Additional Higgs superfields
Subdominant contributions
to EW Higgs fields
Moderate violation of YU
Acceptable m_b**



CMSSM with 'asymptotic' quasi-Yukawa Unification

- Based on Pati-Salam Group $SU(4)_c \times SU(2)_L \times SU(2)_R$
- $\text{sign}(\mu) > 0$
- LSP is neutralino $\tilde{\chi}$
(mostly bino)
- Free parameters ($\tan\beta$ is restricted) :

$M_{1/2}$: gaugino mass

m_0 : scalar mass

A_0 : trilinear scalar
coupling constant

CMSSM with 'asymptotic' quasi-Yukawa Unification

quasi-YU relations

$$h_t : h_b : h_\tau = |1+c| : |1-c| : |1+3c|$$

$$0 < c < 1$$

Deviation from YU

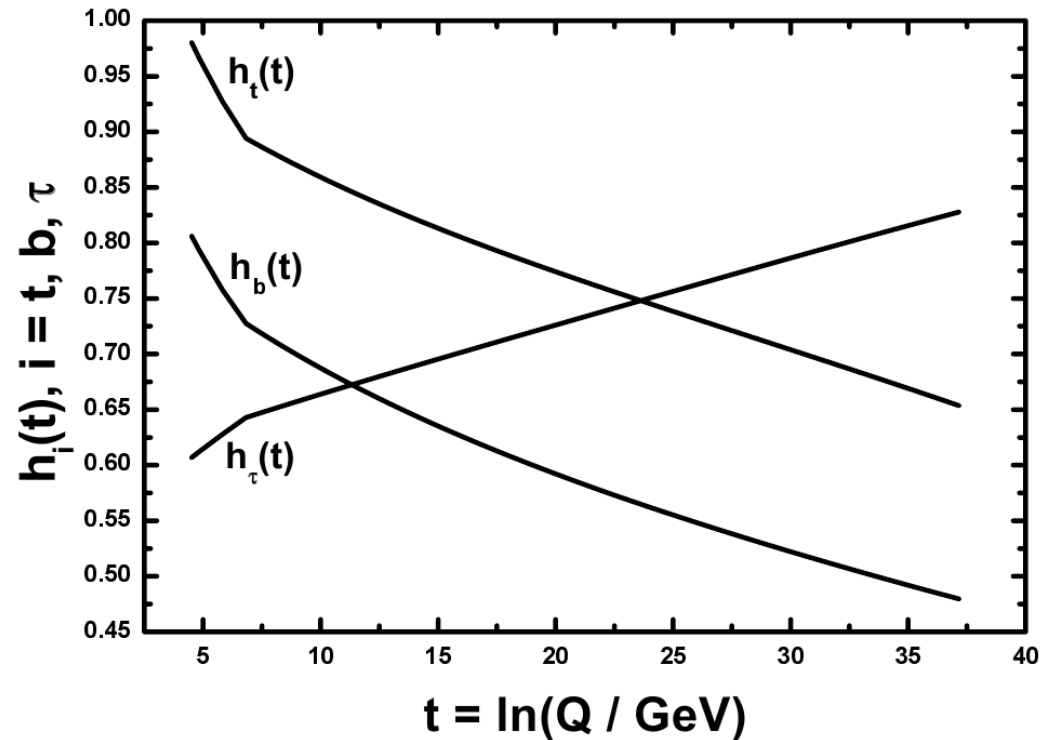
$$\delta h_b \equiv \frac{h_b - h_t}{h_t} = -\delta h_\tau \equiv \frac{h_t - h_\tau}{h_t}$$

Allowed region

$$0.149 \leq c \leq 0.168$$

$$0.26 \leq \delta h_\tau = -\delta h_b \leq 0.29$$

$$56.3 \leq \tan\beta \leq 57.7$$



Cosmological and Phenomenological Restrictions (95% c.l.)

- SM Fermion Masses

DR b quark mass $2.745 \leq m_b(M_Z)^{\overline{DR}} / GeV \leq 3.13$

b quark central value mass $m_t(M_Z) = 2.84 GeV$

t quark central pole mass $M_t = 173 GeV$

t quark running mass $m_t(m_t) = 164.6 GeV$

τ lepton mass $m_\tau(M_Z) = 1.748 GeV$

- Cold Dark Matter considerations

LSP abundance $\Omega_{LSP} h^2 \leq 0.12$

Cosmological and Phenomenological Restrictions (95% c.l.)

- Branching Ratio **BR(b->sγ)** $2.84 \times 10^{-4} \leq BR(b \rightarrow s\gamma) \leq 4.2 \times 10^{-4}$
- Branching Ratio **BR(B_s->μ⁺μ⁻)** $BR(B_s \rightarrow \mu^+ \mu^-) \leq 5.8 \times 10^{-8}$
- Branching Ratio **BR(B_u->τν)** $0.52 \leq BR(B_u \rightarrow \tau\nu) \leq 2.04$
- **Muon Anomalous Magnetic Moment (e⁺e⁻ & τ-decay)**
 $12.7 \times 10^{-10} \leq \delta\alpha_\mu \leq 44.7 \times 10^{-10}$ $2.9 \times 10^{-10} \leq \delta\alpha_\mu \leq 36.1 \times 10^{-10}$
- Collider Bounds
lightest CP-even neutral Higgs boson mass $m_h \geq 114.4 \text{ GeV}$

Restrictions on LSP

Upper bounds on LSP

$$\Omega_{LSP} h^2 \leq 0.12$$

$$\delta\alpha_\mu \geq 2.9 \times 10^{-10}$$

Lower bounds on LSP

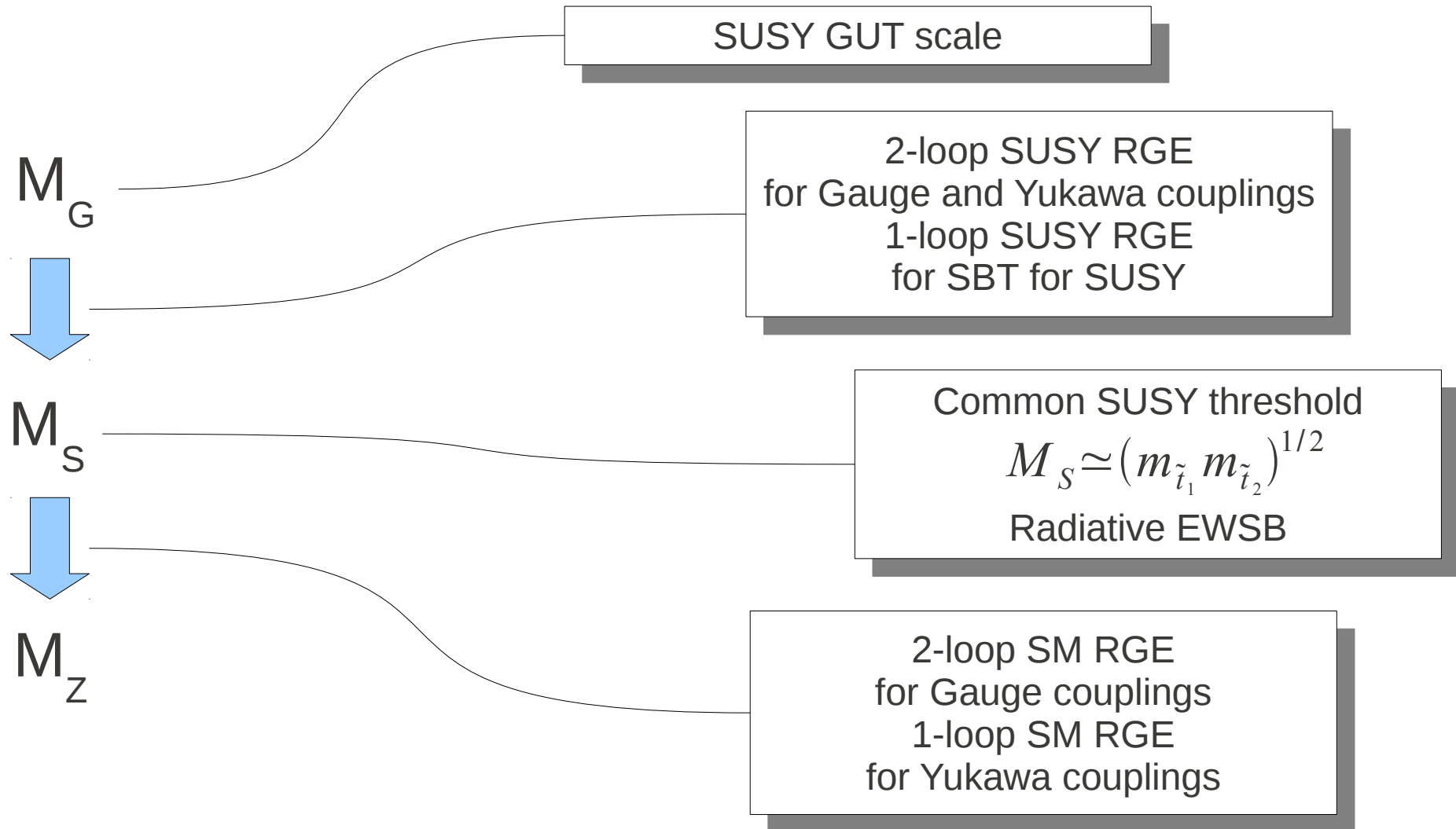
$$BR(b \rightarrow s\gamma) \geq 2.84 \times 10^{-4}$$

$$BR(B_s \rightarrow \mu^+ \mu^-) \leq 5.8 \times 10^{-8}$$

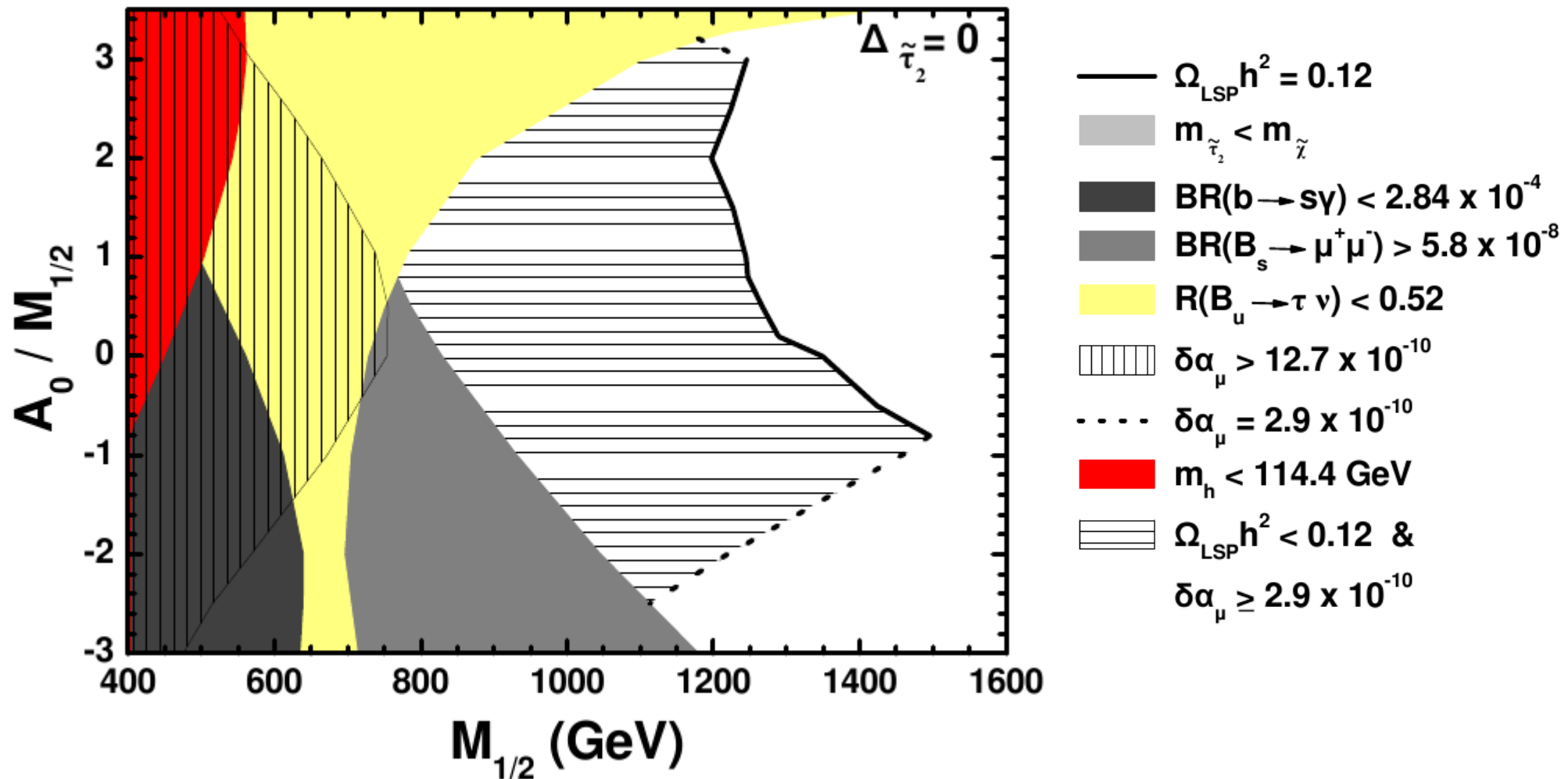
$$BR(B_u \rightarrow \tau\nu) \geq 0.52$$

$$m_h \geq 114.4 \text{ GeV}$$

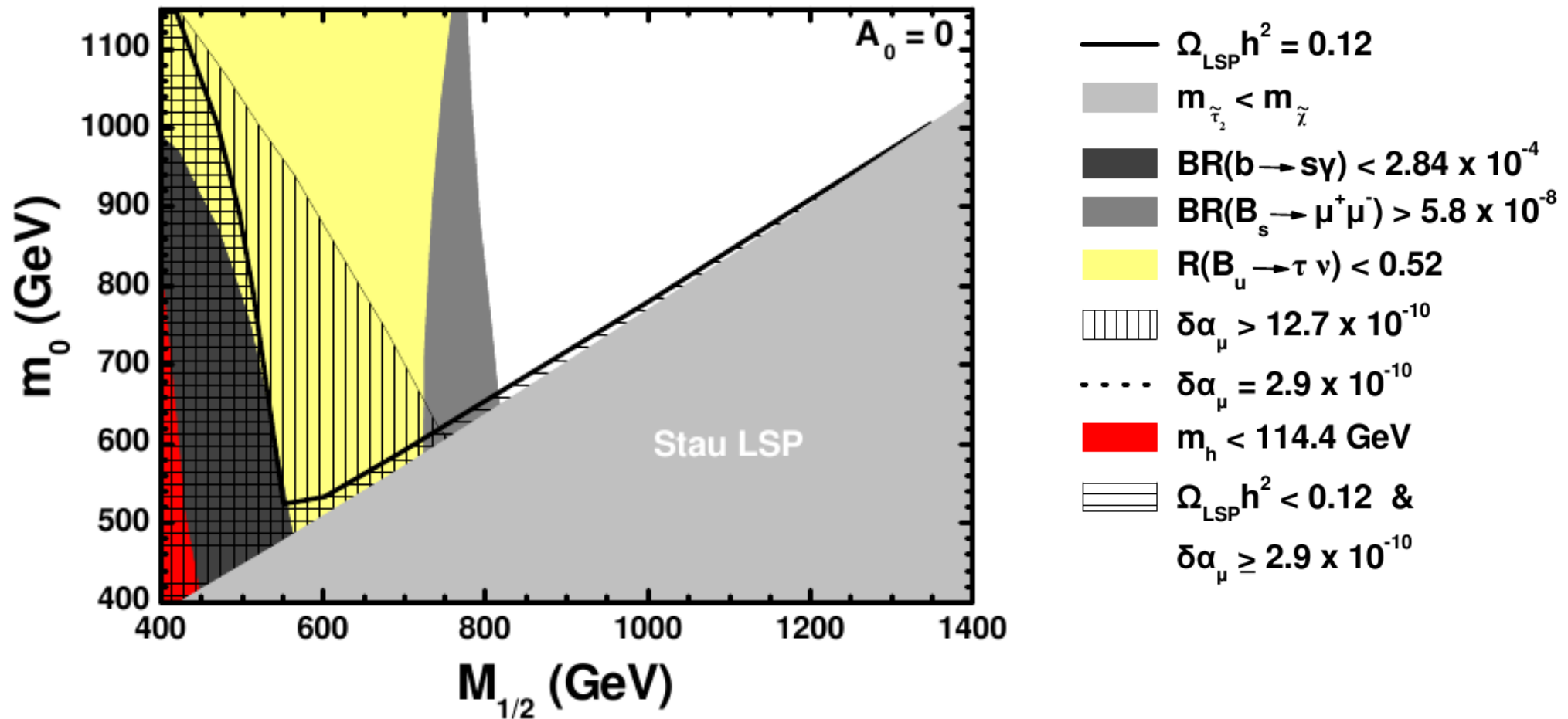
RGE



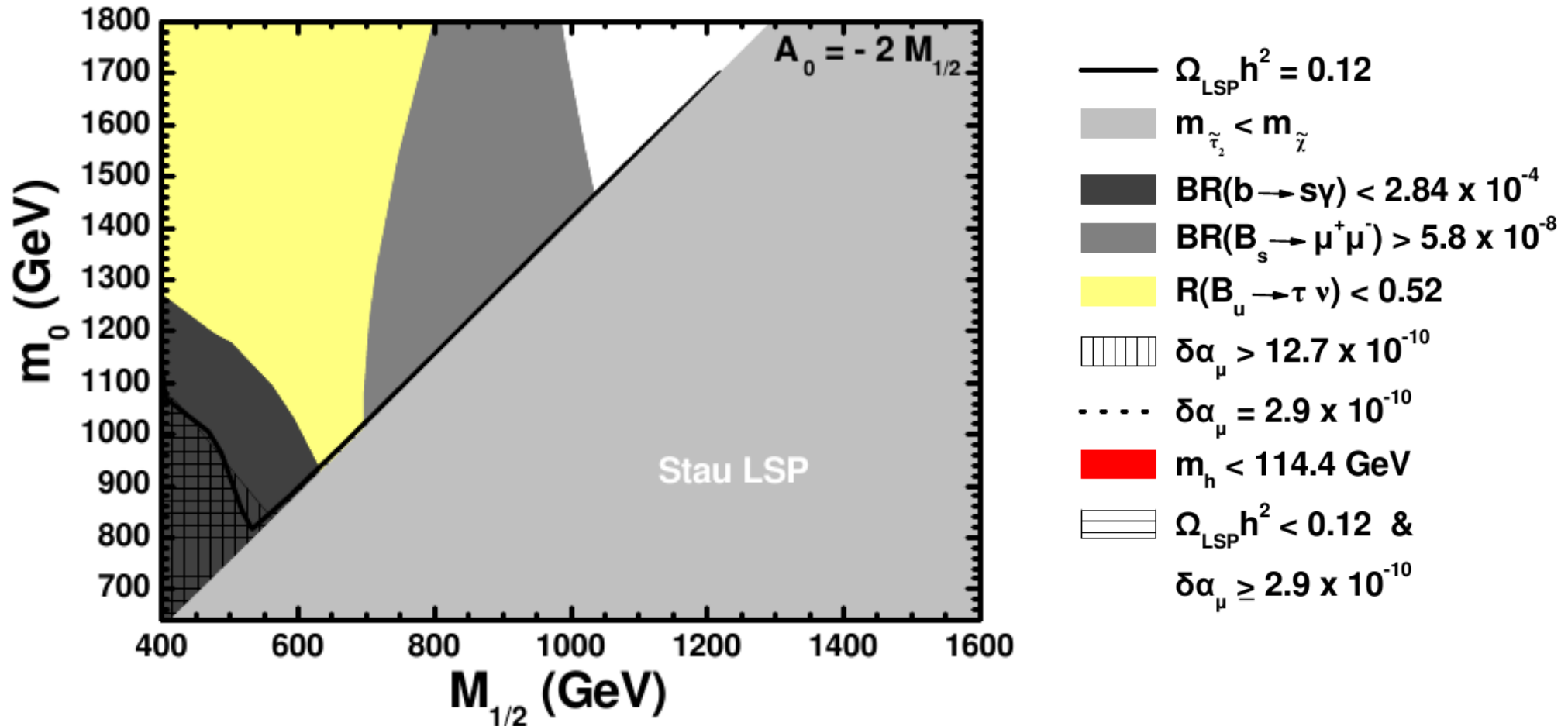
Restrictions in the $M_{1/2} - A_0/M_{1/2}$ plane



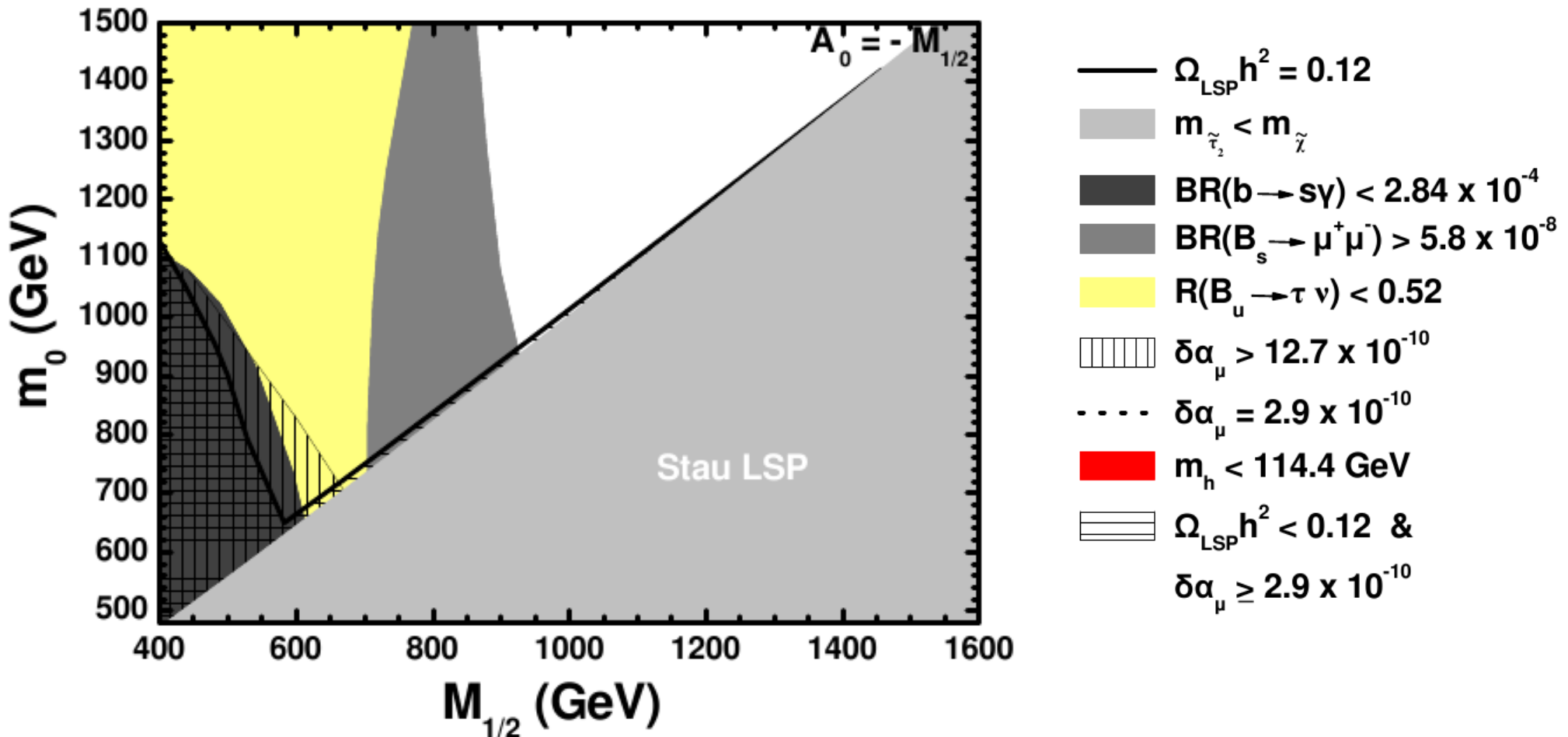
Restrictions in the $M_{1/2} - m_0$ plane



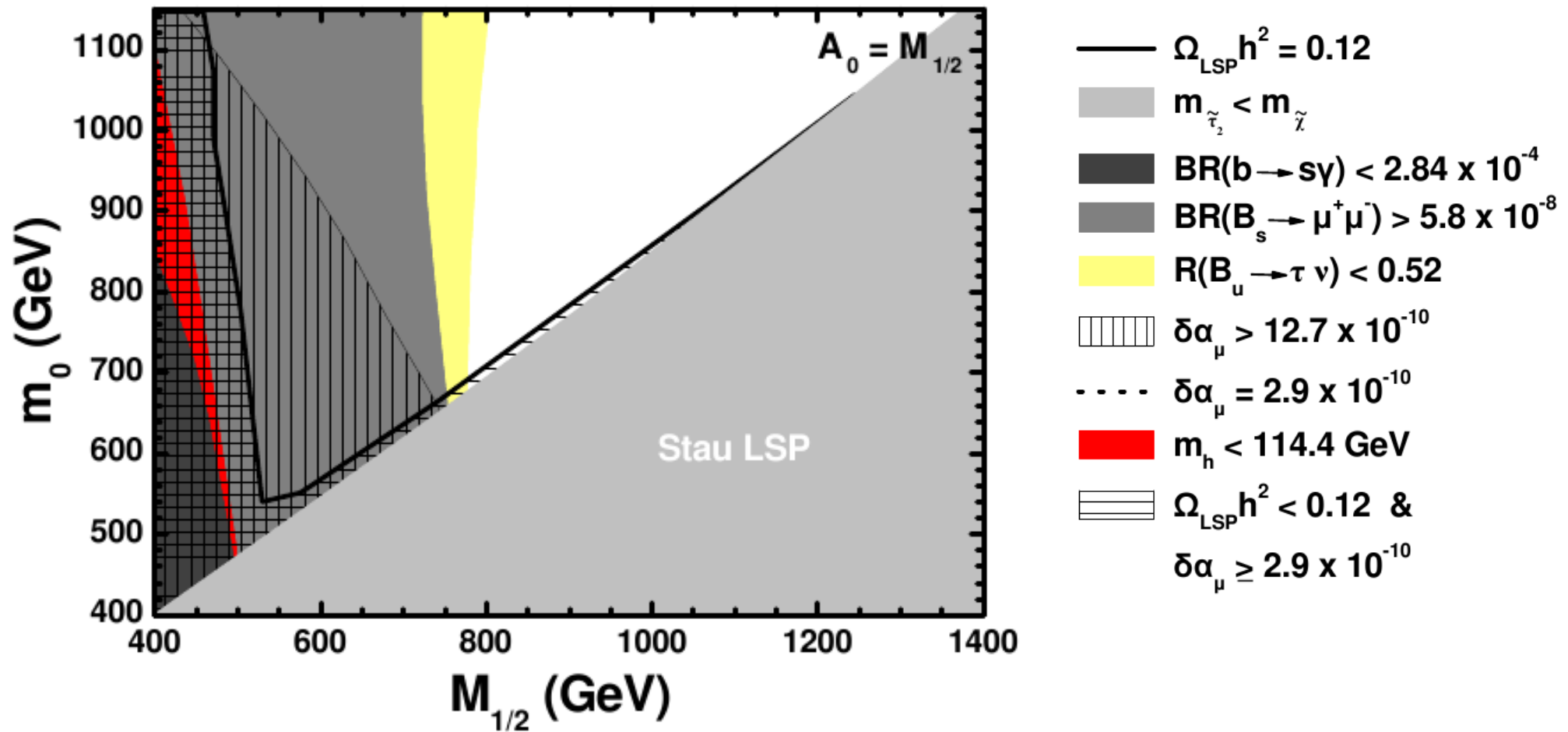
Restrictions in the $M_{1/2} - m_0$ plane



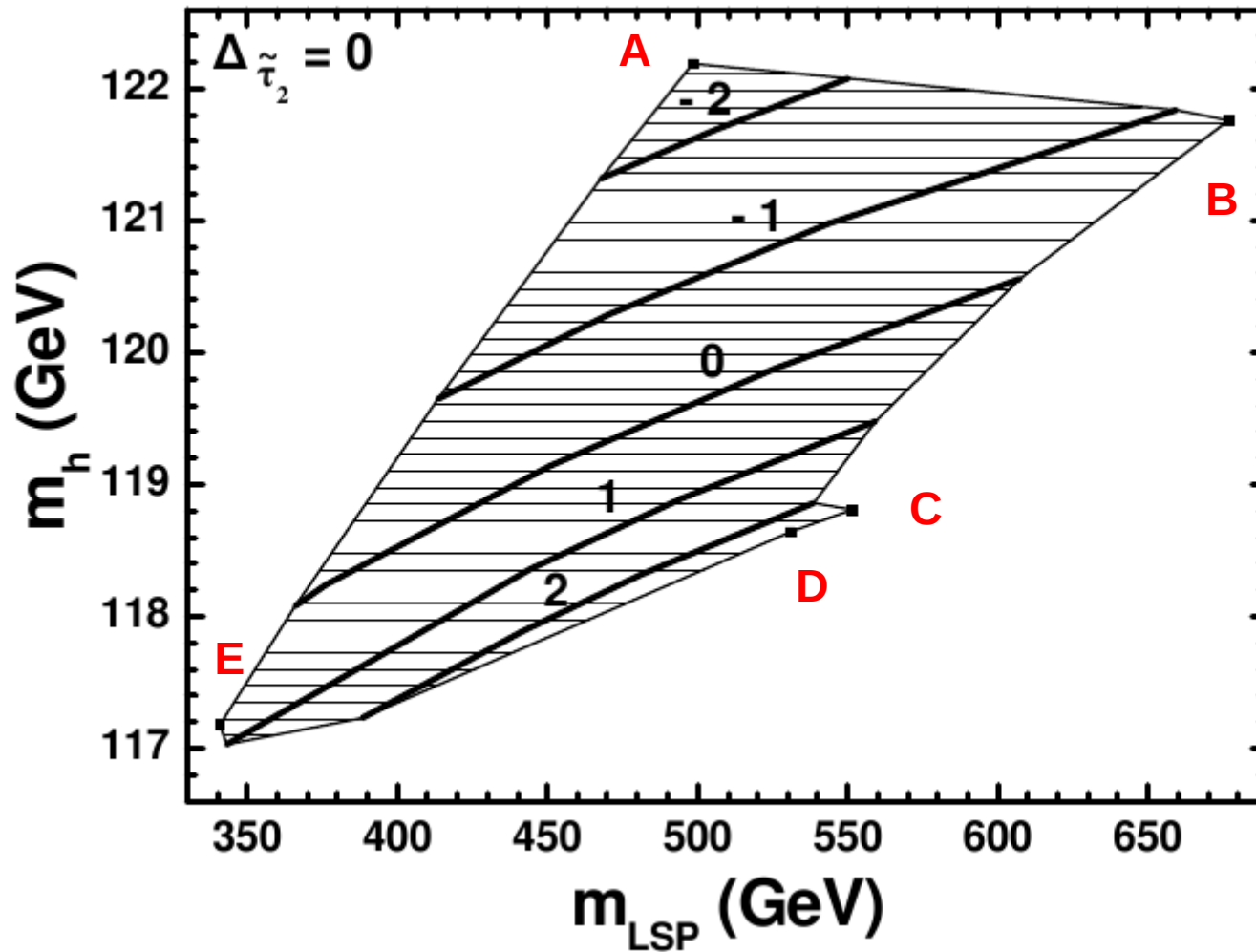
Restrictions in the $M_{1/2} - m_0$ plane



Restrictions in the $M_{1/2} - m_0$ plane



Allowed region in the $m_{LSP} - m_h$ plane



A : $A_0/M_{1/2} = -2.55$

B : $A_0/M_{1/2} = -0.8$

C : $A_0/M_{1/2} = 3$

D : $A_0/M_{1/2} = 3.21$

E : $A_0/M_{1/2} = 0.8$

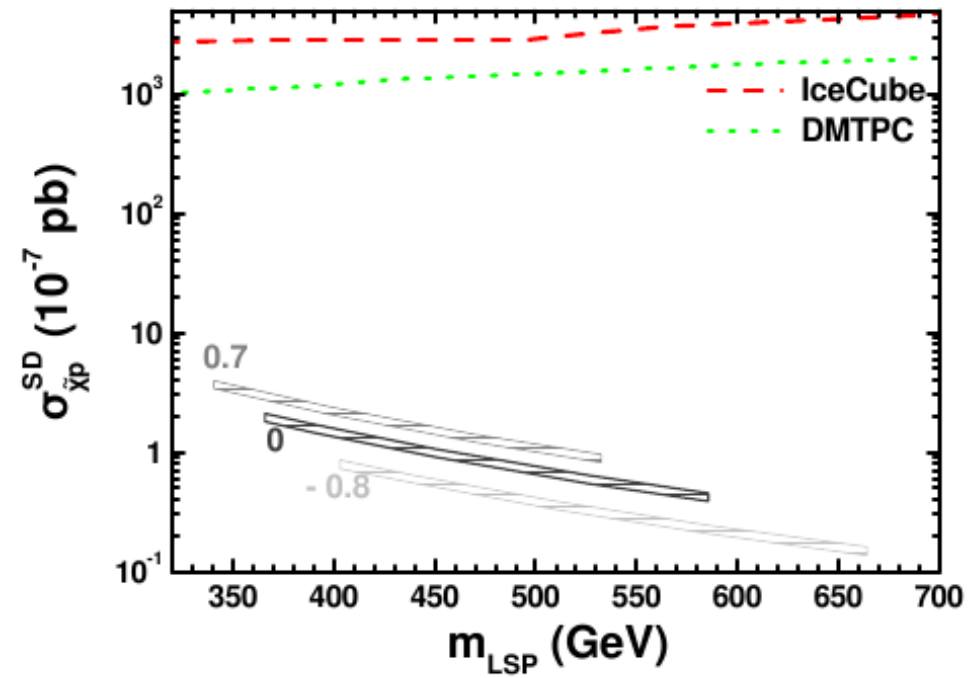
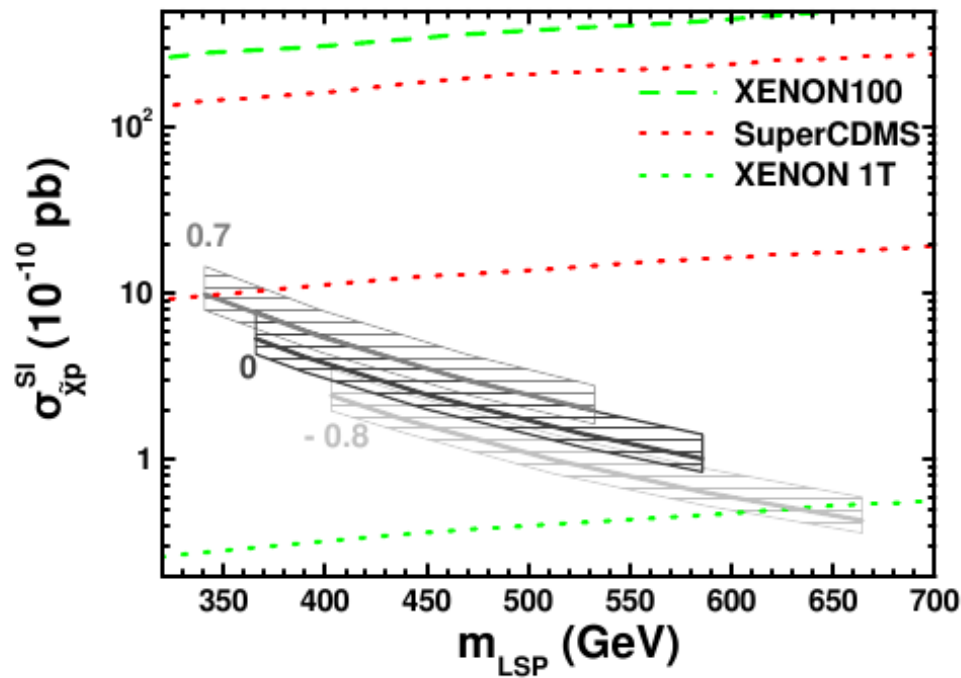
lower bound for -2, -1, 0
 $BR(B_s \rightarrow \mu^+ \mu^-) \leq 5.8 \times 10^{-8}$

lower bound for 1, 2
 $0.52 \leq BR(B_u \rightarrow \tau \nu)$

upper bound for 0, 1, 2
 $\Omega_{LSP} h^2 \leq 0.12$

upper bound for -1, -2
 $\delta \alpha_\mu \geq 2.9 \times 10^{-10}$

SI and SD $\tilde{\chi} - p$ cross sections vs m_{LSP} ($A_0/M_{1/2} = 0.7, 0, -0.8$)



Scalar form factors

$$f_{Tu}^p = 0.024^{+0.0095}_{-0.0032}$$

$$f_{Td}^p = 0.029^{+0.0012}_{-0.0042}$$

$$f_{Ts}^p = 0.021^{+0.0025}_{-0.0013}$$

Axial form factors

$$\Delta_u^p = +0.842 \pm 0.012$$

$$\Delta_d^p = -0.427 \pm 0.013$$

$$\Delta_s^p = -0.085 \pm 0.018$$

Conclusions

- Small range of parameters
- Consistent with cosmological and phenomenological constraints
- For $A_0=0$ we find :

$$365.9 \leq m_{LSP}/GeV \leq 607.4 \quad 118.1 \leq m_h/GeV \leq 120.6$$

- In the overall allowed region we find :

$$-2.55 \leq A_0/M_{1/2} \leq 3.21 \quad 341 \leq m_{LSP}/GeV \leq 677 \quad 117 \leq m_h/GeV \leq 122.2$$

- Accessible in future CDM direct experiments (SI $\tilde{\chi} - p$ cross sections)

From the overall upper bound of the LSP (variation of f and Δ within 1σ) :

$$\sigma_{\tilde{\chi} p}^{SI} \geq 4.3 (3.6) \times 10^{-11} pb \quad \sigma_{\tilde{\chi} p}^{SD} \geq 1.5 (1.4) \times 10^{-8} pb$$

*To Prof. Lazarides, Dr. Pallis
and all the people here in Corfu2011*

Thank you!