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## **Higgs and Sparticle Spectroscopy**

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## The SM Higgs Boson Mass

$$m_h = \sqrt{\lambda} v$$

From the condition of perturbativity and triviality

$$0.8 < \sqrt{\lambda} < 1.1 \Rightarrow 130 < m_h < 180$$

$$\frac{d}{dt} \lambda = \frac{\lambda}{16\pi^2} [12\lambda^2 - 12h_t^4 + \dots]$$

## The MSSM Higgs Boson Mass

In the MSSM, the lightest CP-even Higgs boson mass is (when  $M_A \sim M_{\text{SUSY}}$ )

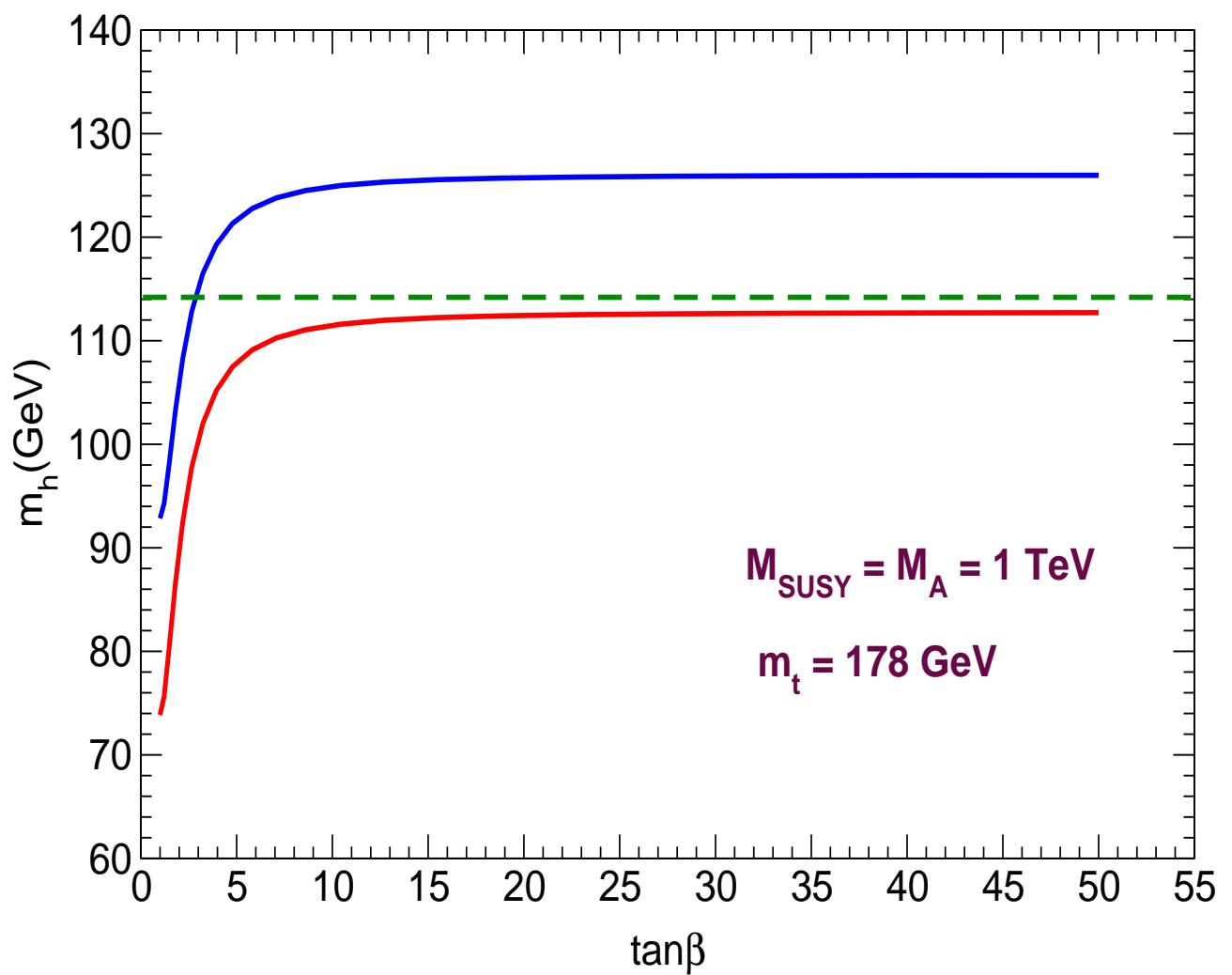
$$\begin{aligned} m_h^2 = & \frac{g^2 + g'^2}{2} v^2 \cos^2 2\beta \left( 1 - \frac{3}{8\pi^2} \frac{m_t^2}{v^2} t \right) \\ & + \frac{3}{4\pi^2} \frac{m_t^4}{v^2} \left[ \frac{1}{2} \tilde{X}_t + t \right. \\ & \left. + \frac{1}{16\pi^2} \left( \frac{3}{2} \frac{m_t^2}{v^2} - 32\pi\alpha_3 \right) (\tilde{X}_t t + t^2) \right] \end{aligned}$$

where

$$t = \log \frac{M_{\text{SUSY}}^2}{m_t^2}, \quad \tilde{A}_t = A_t - \mu \cot \beta$$

$$\tilde{X}_t = \frac{2\tilde{A}_t^2}{M_{\text{SUSY}}^2} \left( 1 - \frac{\tilde{A}_t^2}{12M_{\text{SUSY}}^2} \right)$$

## The MSSM case



## The CMSSM

$m_0, m_{1/2}, A_0, \tan \beta, \text{sign}(\mu),$   
 $M_{GUT} \simeq 2 \times 10^{16} \text{ GeV}$

### Scanning procedure

Bounds from the LEP2 experiment

**Chargino mass to be**  $m_{\widetilde{W}_1^+} \geq 103.5 \text{ GeV}$ , **the lighter stop squark mass**  $m_{\tilde{t}_1} \geq 101.5 \text{ GeV}$  and  $m_{\tilde{\tau}_1} \geq 98.8 \text{ GeV}$  **for the lighter stau slepton mass provided the mass difference**  $m_{\tilde{\tau}_1} - m_{\widetilde{W}_1^0} > 10 \text{ GeV}$ .

**We use constraints coming from combination of WMAP and the Sloan Digital Sky Survey data**

$$\Omega_{\text{CDM}} h^2 = 0.111_{-0.015}^{+0.011} \quad (2\sigma)$$

We use the following range for the muon anomalous magnetic moment  $a_\mu = \frac{(g-2)_\mu}{2}$

$$-5.7 \cdot 10^{-10} \leq \alpha_{\mu, \text{SUSY}} \leq 4.7 \cdot 10^{-9}$$

Combining experimental and theoretical errors in quadratures we apply the following constraints at  $2\sigma$  level in our study:

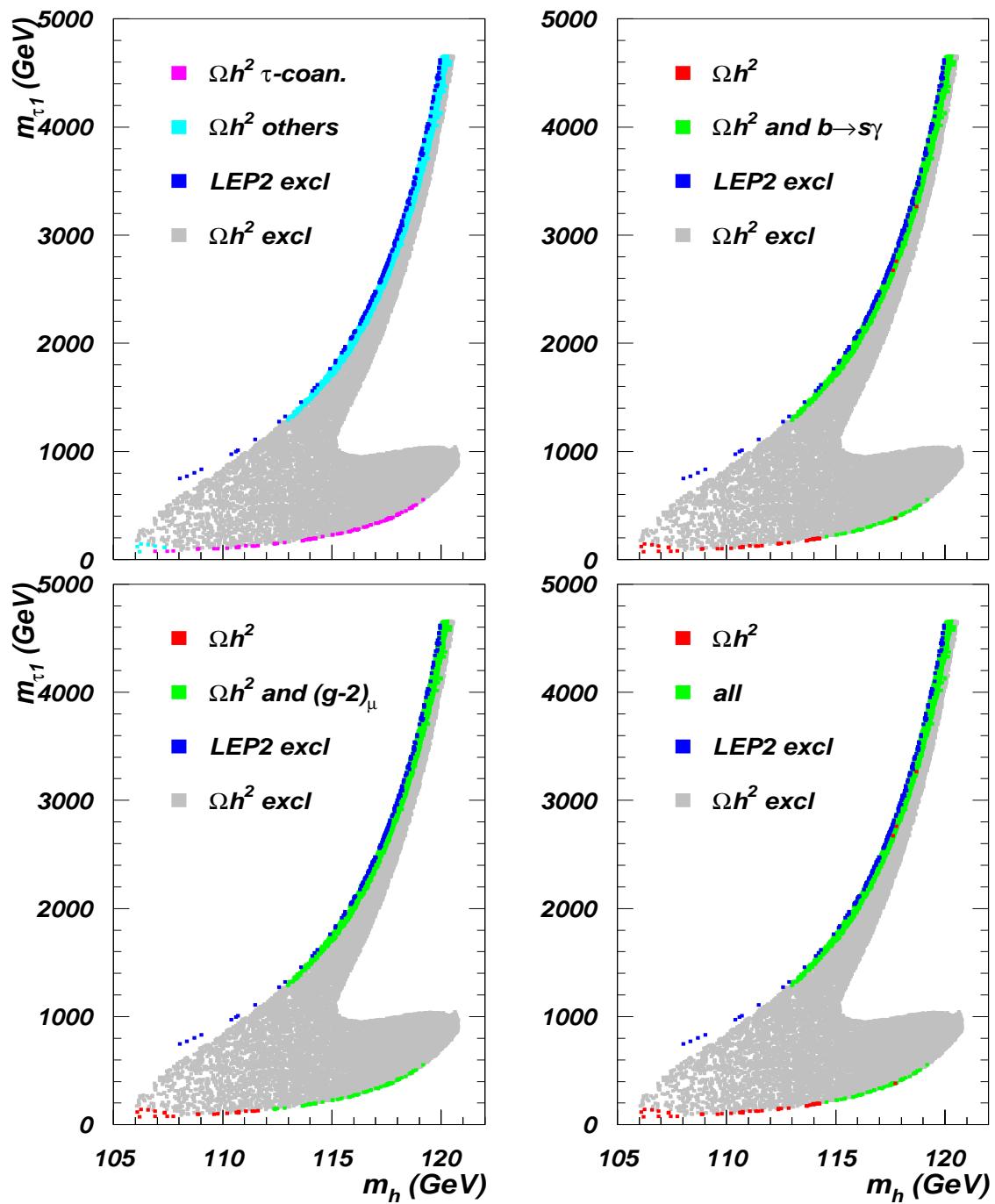
$$2.85 \cdot 10^{-4} \leq Br(b \rightarrow s\gamma) \leq 4.24 \cdot 10^{-4}.$$

## Numerical calculation

$$0 \leq m_0 \leq 5 \text{ TeV}, \quad 0 \leq m_{1/2} \leq 2 \text{ TeV}$$

$$A_0 = 0, -1 - 2 \text{ TeV}, \quad \tan \beta = 10, 30, 50$$

with  $\mu > 0$  and  $m_t = 171.4 \text{ GeV}$ .



## Figures

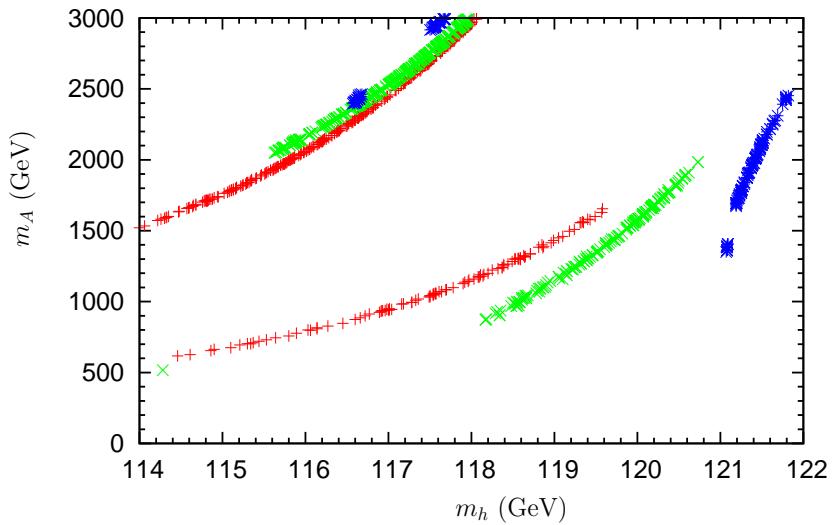


FIG. 1: Allowed region for CP odd Higgs mass versus  $m_h$  (with  $\tan\beta = 30$ ). Red (+), green (x) and blue (\*) correspond to  $A_0 = 0, -1$  and  $-2$  TeV respectively.

## Figures

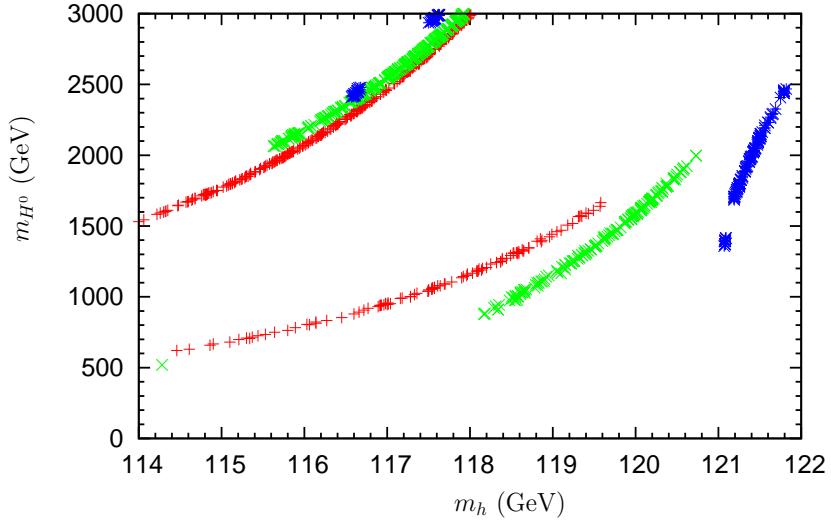


FIG. 1: Allowed region for neutral Higgs mass versus  $m_h$  (with  $\tan \beta = 30$ ). Red (+), green (x) and blue (\*) correspond to  $A_0 = 0, -1$  and  $-2$  TeV respectively.

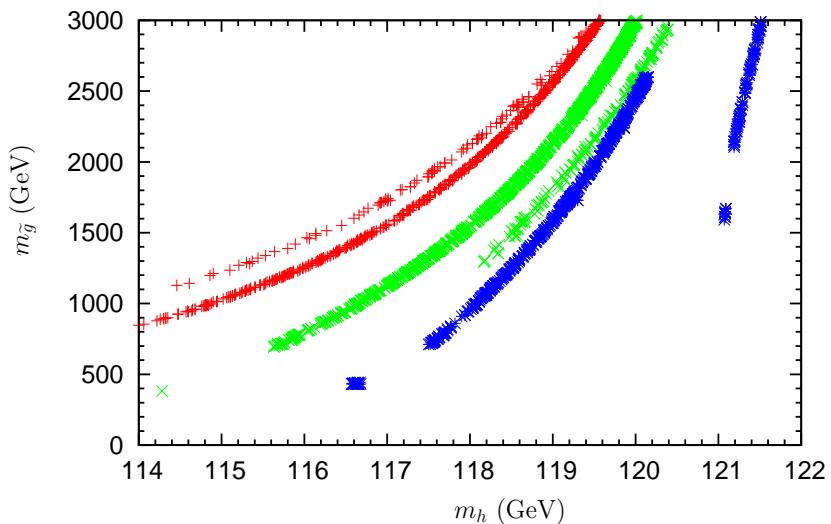


FIG. 2: Allowed region for gluino mass versus  $m_h$  (with  $\tan \beta = 30$ ). Red (+), green (x) and blue (\*) correspond to  $A_0 = 0, -1$  and  $-2$  TeV respectively.

## Figures

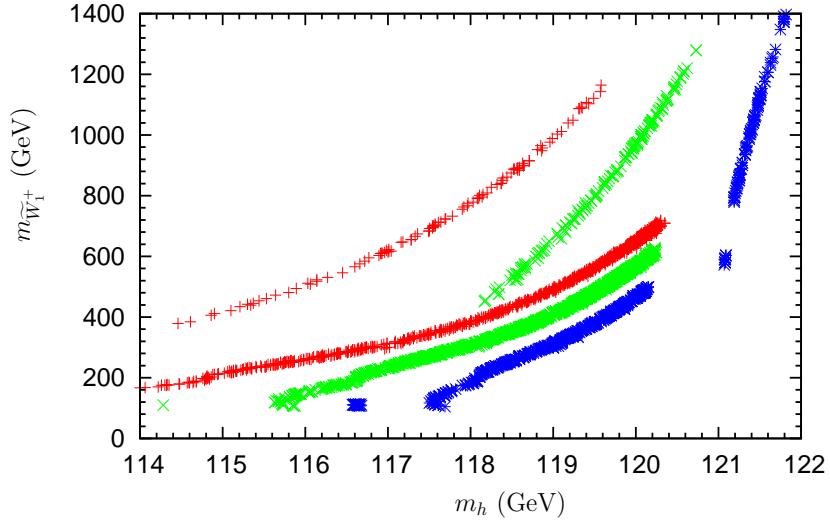


FIG. 1: Allowed region for wino mass versus  $m_h$  (with  $\tan \beta = 30$ ). Red (+), green (x) and blue (\*) correspond to  $A_0 = 0, -1$  and  $-2$  TeV respectively.

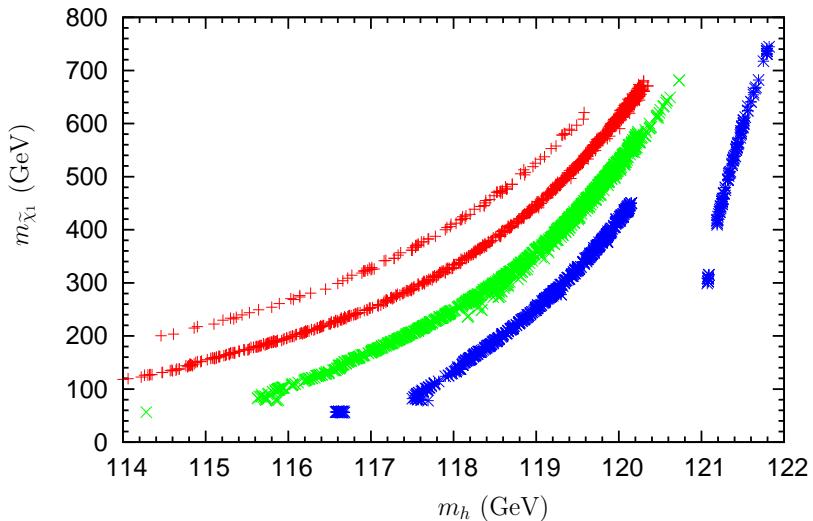


FIG. 2: Allowed region for lightest neutralino mass versus  $m_h$  (with  $\tan \beta = 30$ ). Red (+), green (x) and blue (\*) correspond to  $A_0 = 0, -1$  and  $-2$  TeV respectively.

## Figures

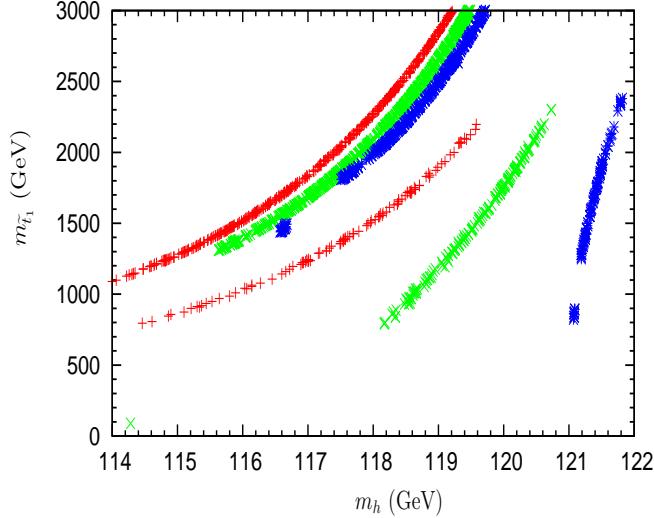


FIG. 1: Allowed region for top squark mass mass versus  $m_h$  (with  $\tan \beta = 30$ ). Red (+), green (x) and blue (\*) correspond to  $A_0 = 0, -1$  and  $-2$  TeV respectively.

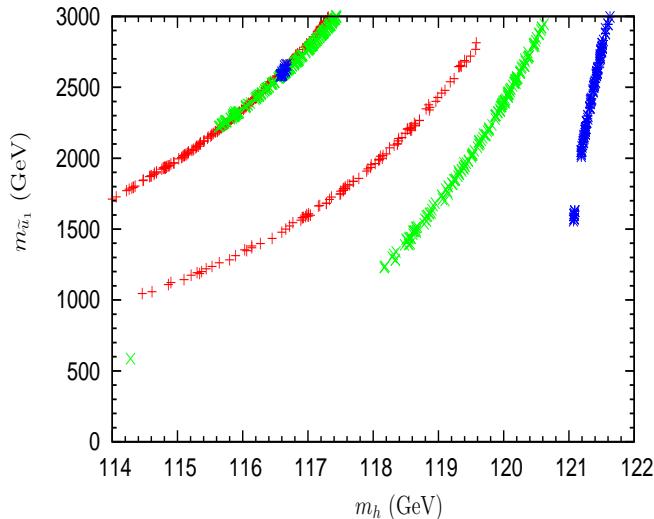


FIG. 2: Allowed region for up squark mass mass versus  $m_h$  (with  $\tan \beta = 30$ ). Red (+), green (x) and blue (\*) correspond to  $A_0 = 0, -1$  and  $-2$  TeV respectively.

## Figures

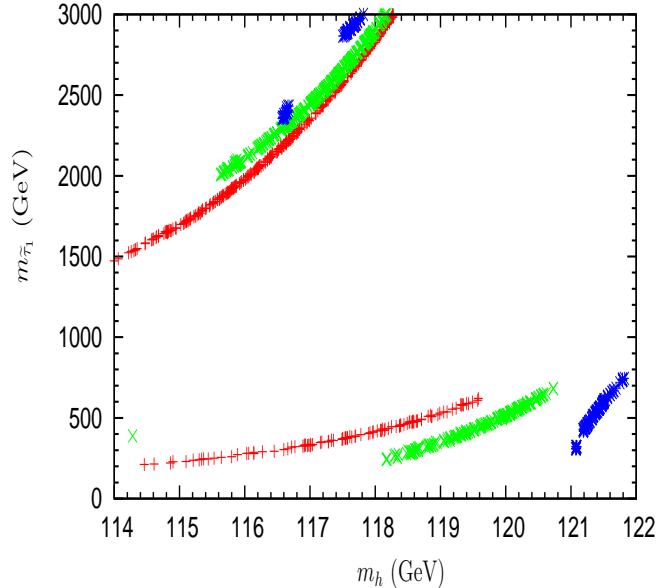


FIG. 1: Allowed region for stau mass mass versus  $m_h$  (with  $\tan \beta = 30$ ). Red (+), green (x) and blue (\*) correspond to  $A_0 = 0, -1$  and  $-2$  TeV respectively.

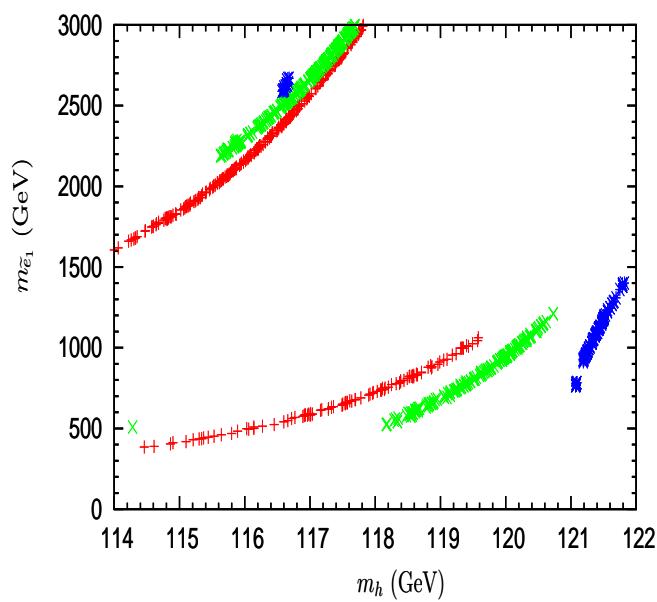


FIG. 2: Allowed region for selectron mass mass versus  $m_h$  (with  $\tan \beta = 30$ ). Red (+), green (x) and blue (\*) correspond to  $A_0 = 0, -1$  and  $-2$  TeV respectively.

## Conclusion

We present an updated scan of the CMSSM parameter space, taking into account the revised (lower) value of  $m_t$ , new information on the sign of the matrix element for  $b \rightarrow s + \gamma$  decay, and dark matter abundance constraint from WMAP3. With  $\mu > 0$ , and for a plausible range of values for  $m_0$ ,  $m_{1/2}$  and  $|A_0|$  and for  $\tan\beta = 30$ , we have provided bounds on the masses of Higgs bosons and sparticles in CMSSM.