Uncertainties in the lightest MSSM Higgs-Boson Mass: m_t Renormalization Scheme Dependence

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mostly based on collaboration with
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From my talk at KUTS 2:

Options for the evaluation of intrinsic uncertainties (II):

5. Compare different renormalizations. Still possible?

6. Variation of m_t to investigate the size of *non-logarithmic* missing corrections (as it is now done in *FeynHiggs* for the sub-leading $\mathcal{O}\left(\alpha_t\alpha_s + \alpha_t^2\right)$ corrections).

7. Intrinsic uncertainties are often split into momentum dependent and independent part. Keep this? Make use of newly evaluated $\mathcal{O}\left(\alpha_s\alpha_t\, p^2\right)$ corrections.

8. ???

$\Rightarrow$ some new results, based on FH2.11.1 and arXiv:1505.03133

Evaluate M_h in two RS for m_t

RS1: m_t OS

RS2: m_t $\overline{\text{DR}}$ (MSSM)

Stop sector always OS

$$m_t^{\overline{\text{DR}}}(\mu) = m_t \cdot \left[1 + \frac{\delta m_t^{\text{fin}}}{m_t} + \mathcal{O}\left(\left(\alpha_s^{\overline{\text{DR}}}\right)^2\right)\right]$$

$$\begin{aligned}\frac{\delta m_t^{\text{fin}}}{m_t} = \alpha_s^{\overline{\text{DR}}}(\mu)\Bigg(&-\frac{5}{3\pi} + \frac{1}{\pi}\log(m_t^2/\mu^2) + \frac{m_{\tilde{g}}^2}{3m_t^2\pi}\left(-1 + \log(m_{\tilde{g}}^2/\mu^2)\right)\\ &+ \frac{1}{6m_t^2\pi}\Big(m_{\tilde{t}_1}^2(1 - \log(m_{\tilde{t}_1}^2/\mu^2)) + m_{\tilde{t}_2}^2(1 - \log(m_{\tilde{t}_2}^2/\mu^2))\\ &+ (m_{\tilde{g}}^2 + m_t^2 - m_{\tilde{t}_1}^2 - 2m_{\tilde{g}}m_t\sin(2\theta_t))\text{Re}[B_0^{\text{fin}}(m_t^2, m_{\tilde{g}}^2, m_{\tilde{t}_1}^2)]\\ &+ (m_{\tilde{g}}^2 + m_t^2 - m_{\tilde{t}_2}^2 + 2m_{\tilde{g}}m_t\sin(2\theta_t))\text{Re}[B_0^{\text{fin}}(m_t^2, m_{\tilde{g}}^2, m_{\tilde{t}_2}^2)]\Big)\Bigg)\end{aligned}$$

Ensure that the "physics" does not change:

⇒ shift soft SUSY-breaking parameters such that stop masses do not change

$$M^2_{\tilde{t}_L} \to M'^2_{\tilde{t}_L} = M^2_{\tilde{t}_L} + (m_t^{\text{OS}})^2 - (m_t^{\overline{\text{DR}}})^2$$

$$M^2_{\tilde{t}_R} \to M'^2_{\tilde{t}_R} = M^2_{\tilde{t}_R} + (m_t^{\text{OS}})^2 - (m_t^{\overline{\text{DR}}})^2$$

$$A_t \to A'_t = \frac{m_t^{\text{OS}}}{m_t^{\overline{\text{DR}}}} \left(A_t - \frac{\mu}{\tan\beta} \right) + \frac{\mu}{\tan\beta}$$

⇒ to be refined in the future . . .

Numerical analysis:

Three "loop-level":

(i) full one-loop

(ii) . . . plus $\mathcal{O}(\alpha_t\alpha_s)$

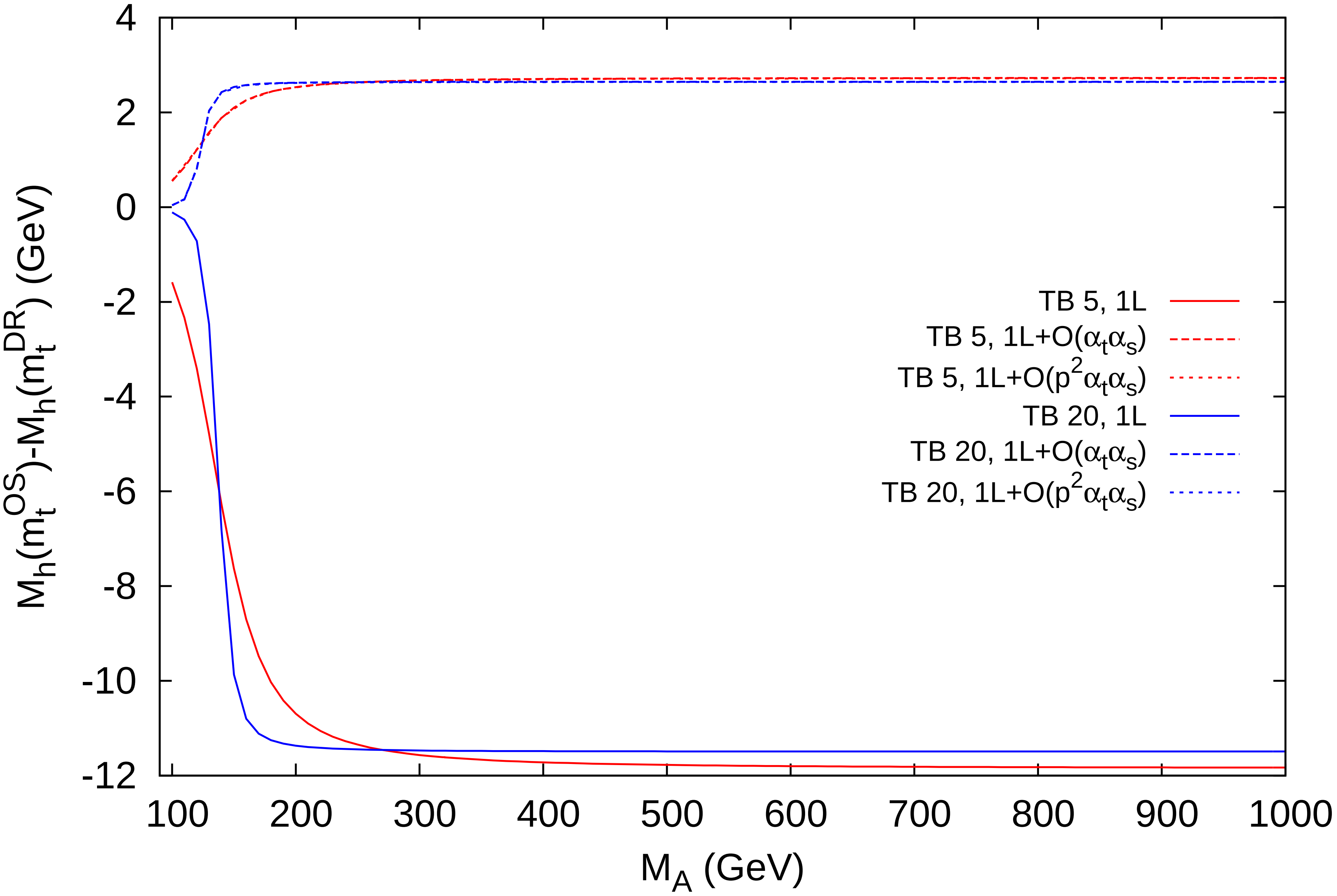
(iii) . . . plus $\mathcal{O}\left(p^2\alpha_t\alpha_s\right)$

Two renormalization schemes:

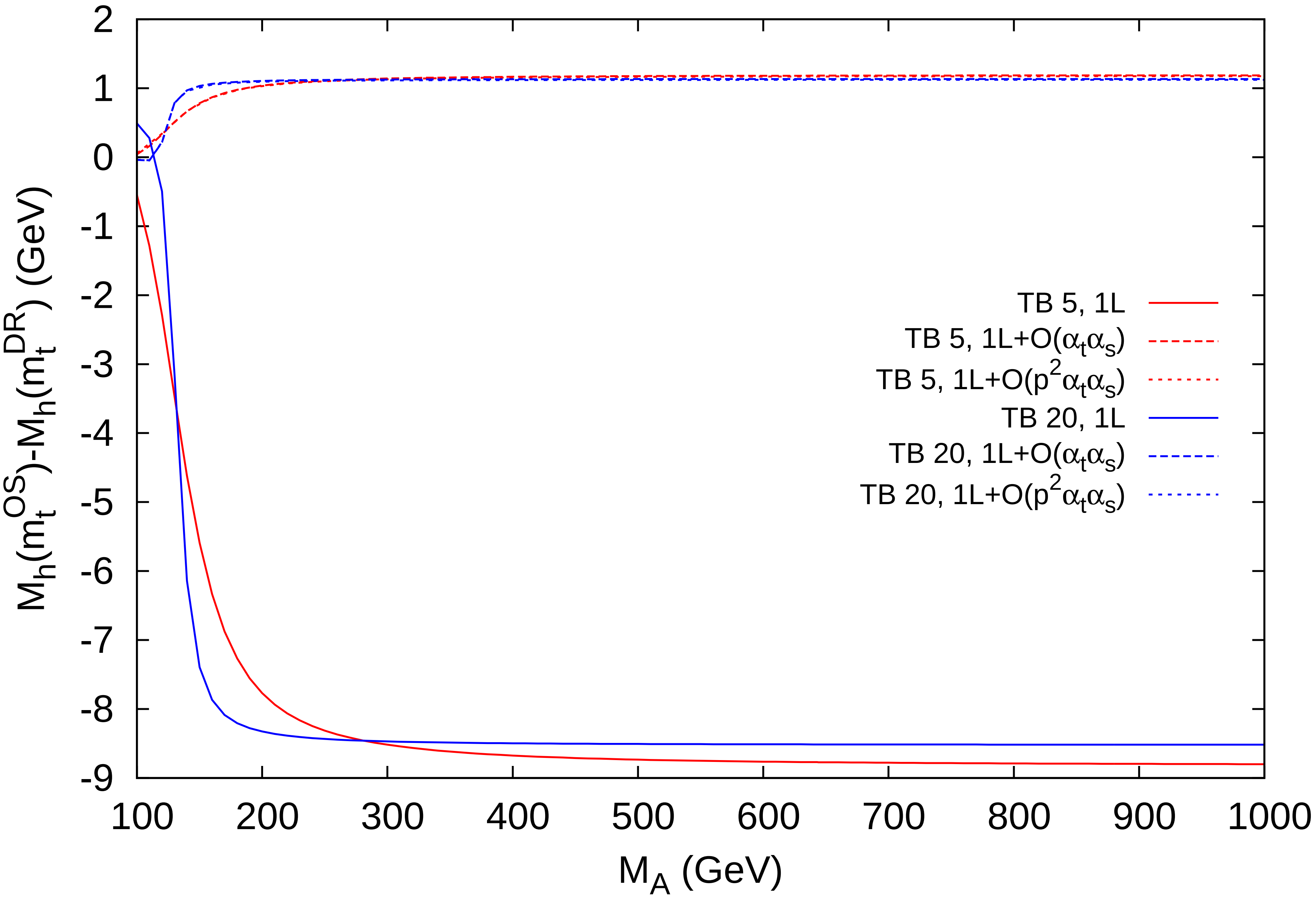
RS1: m_t OS

RS2: m_t $\overline{\text{DR}}$ (MSSM)

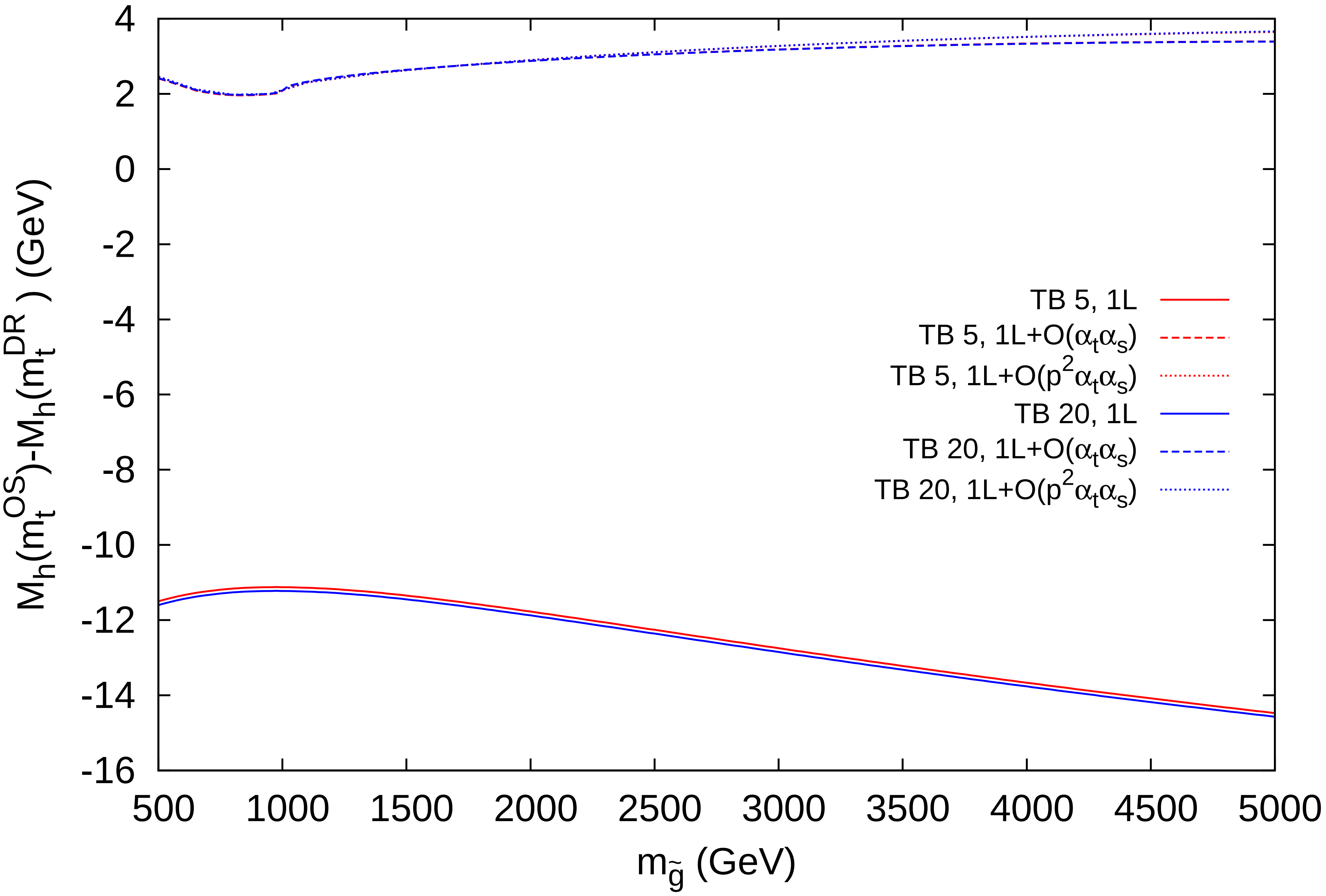
M_A dependence in $m_h^{\rm max}$ scenario:



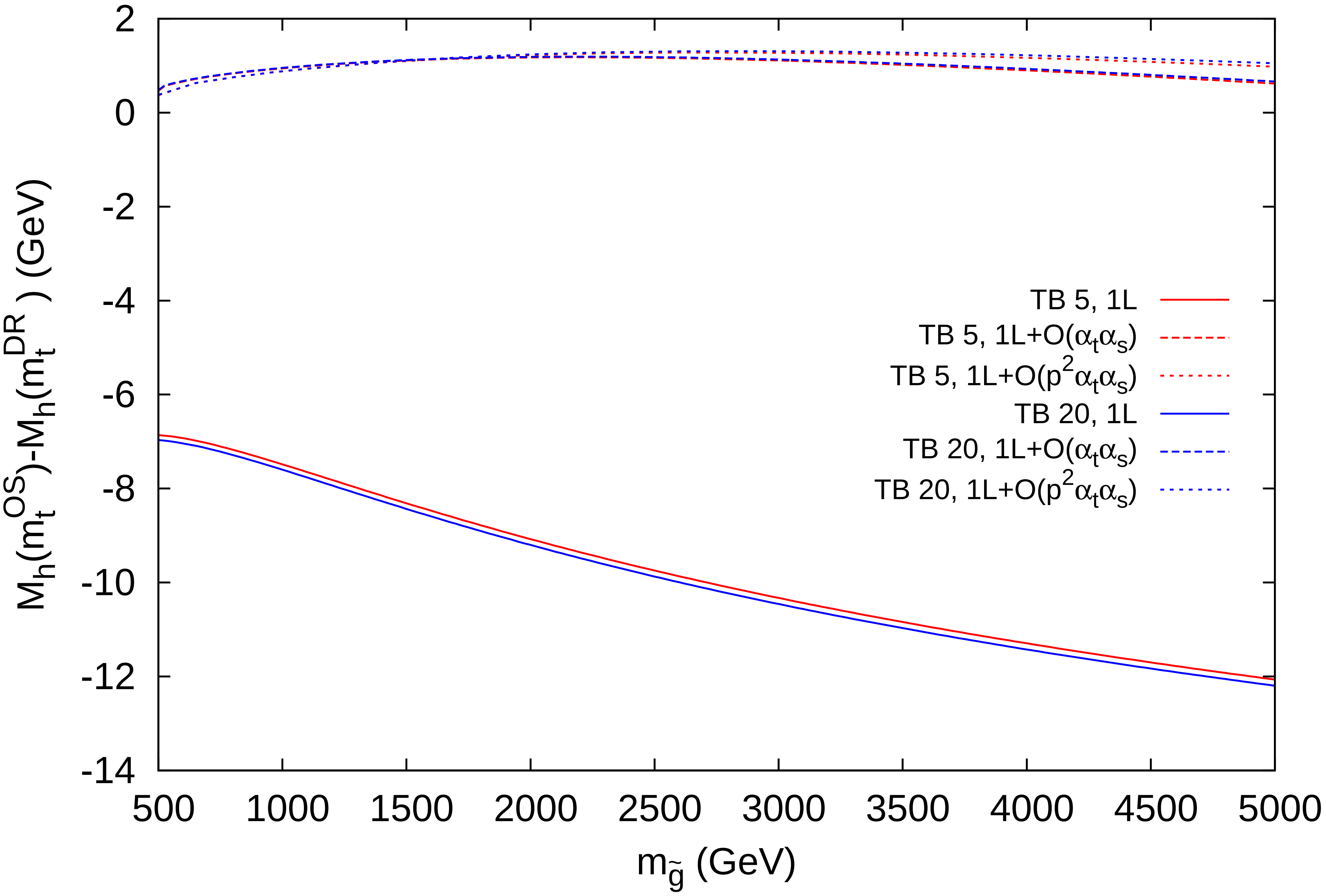
M_A dependence in light-stop scenario:



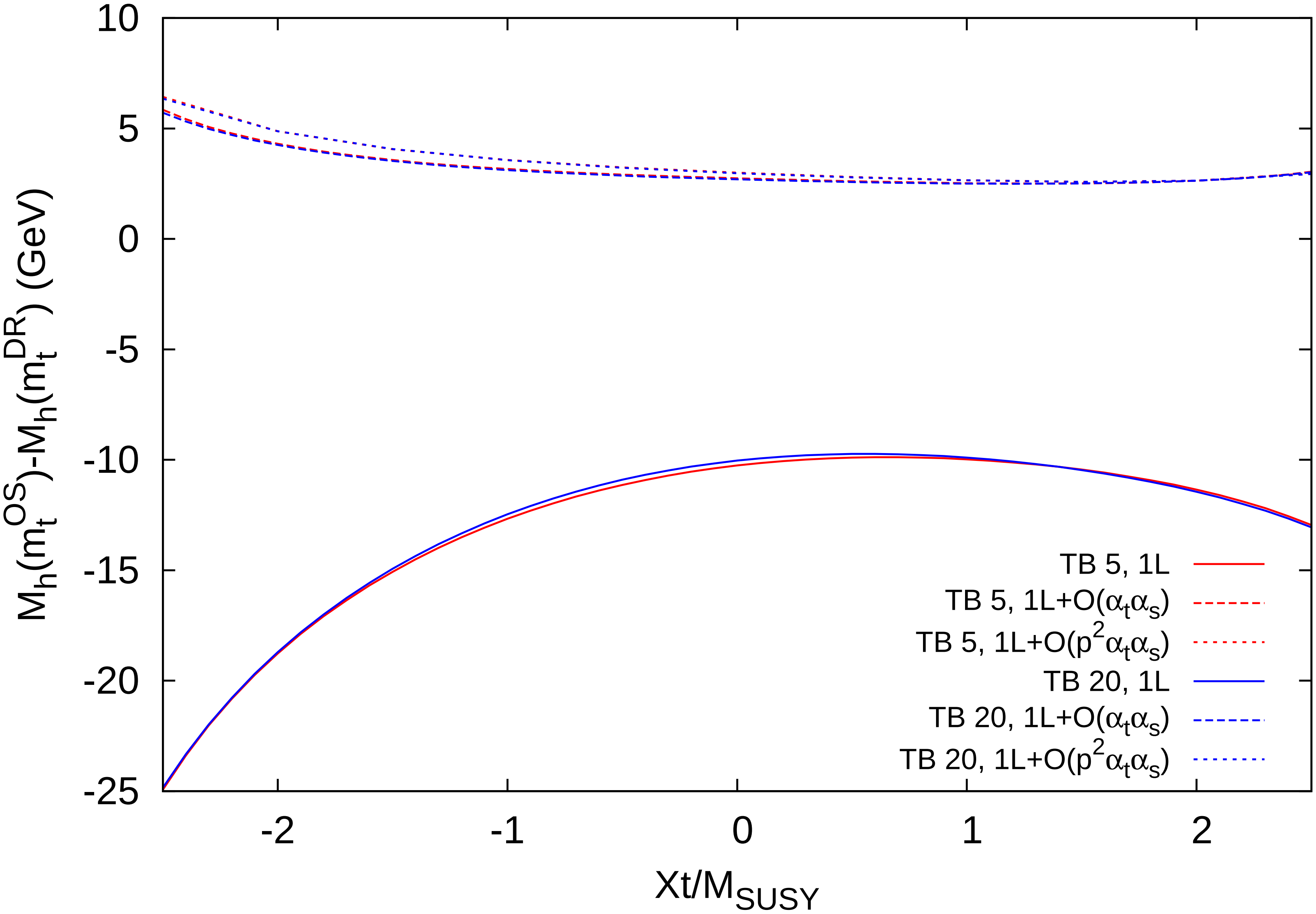
$m_{\tilde{g}}$ dependence in m_h^{max} scenario:



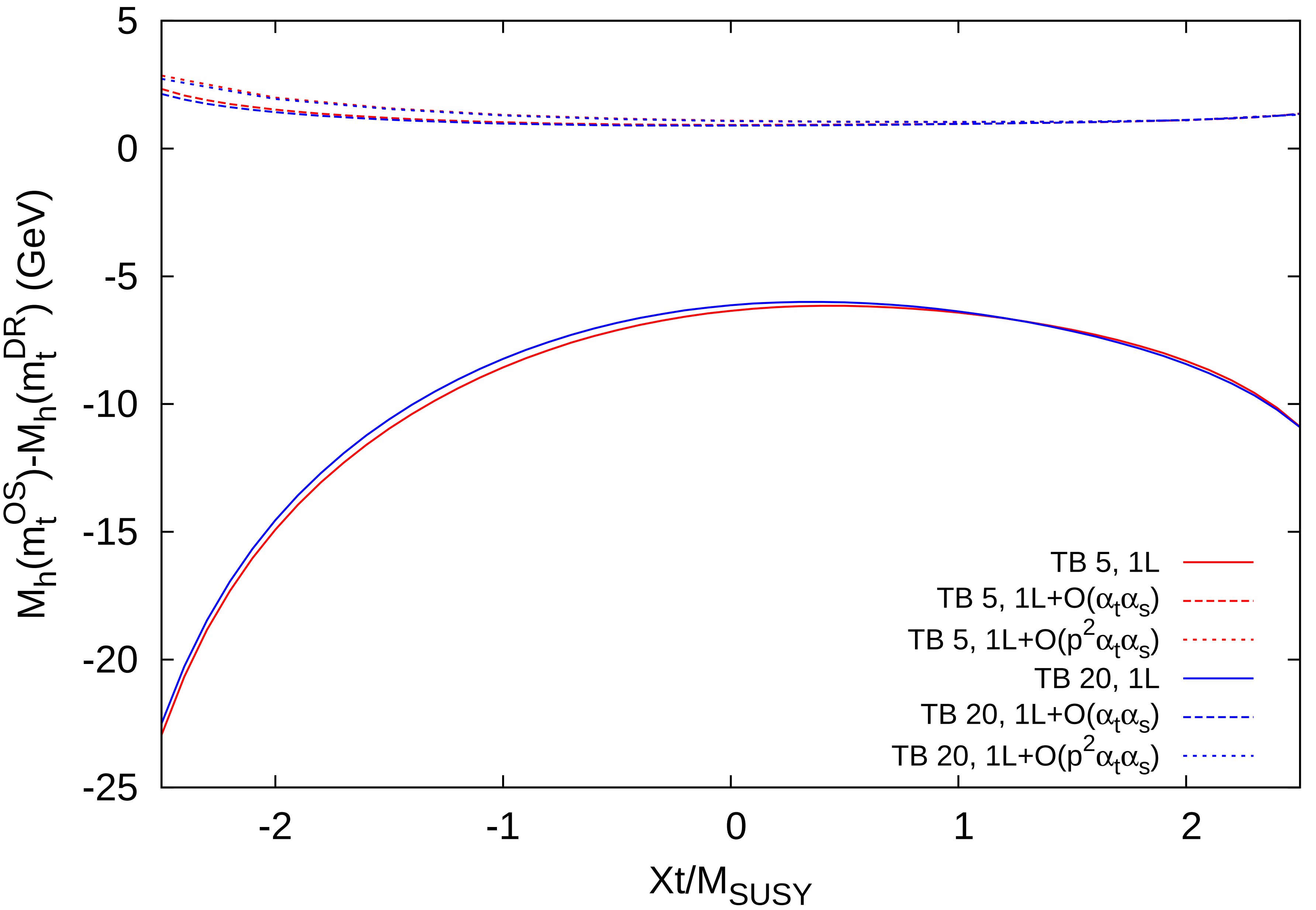
$m_{\tilde{g}}$ dependence in light-stop scenario:



X_t dependence in m_h^{max} scenario:

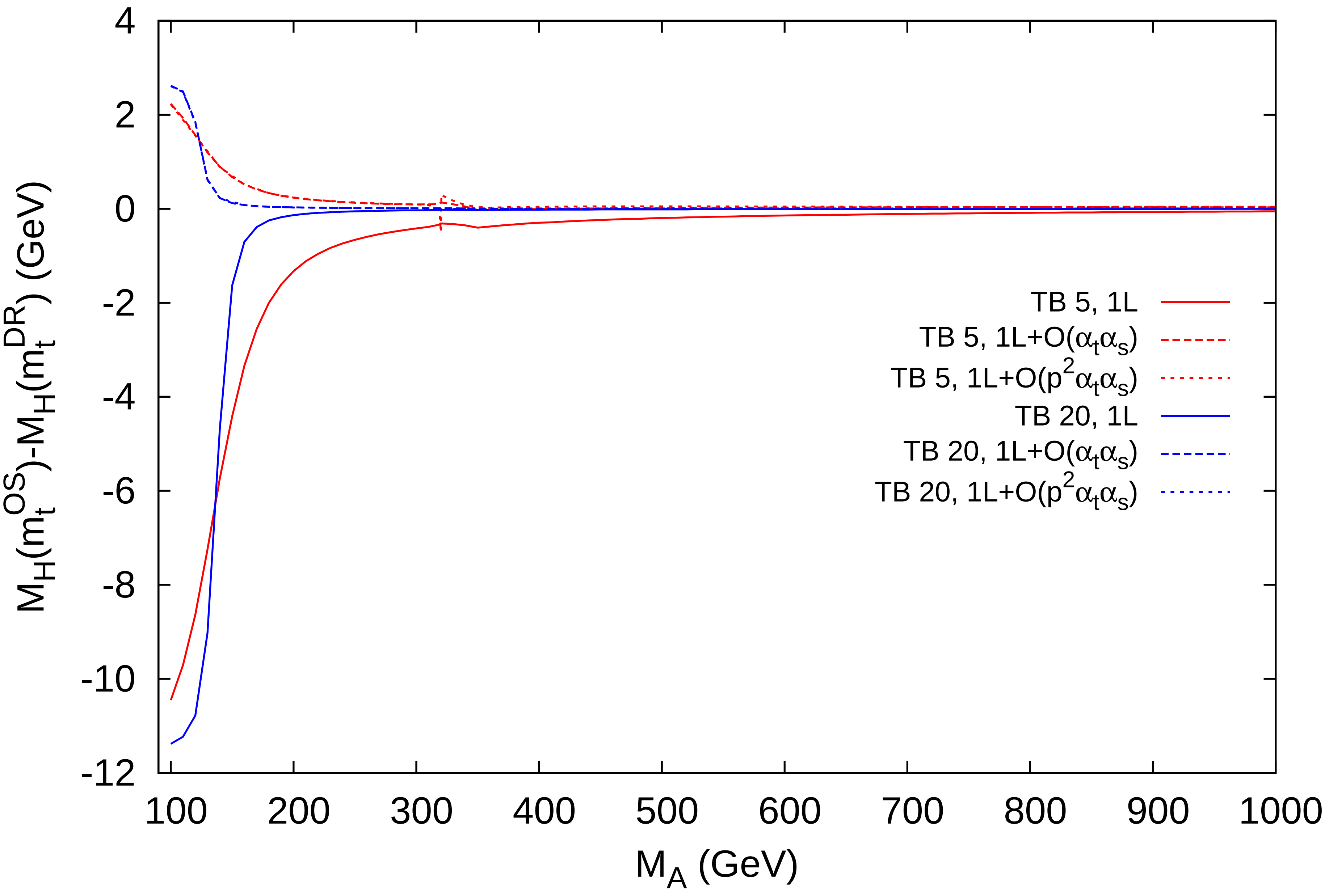


X_t dependence in light-stop scenario:

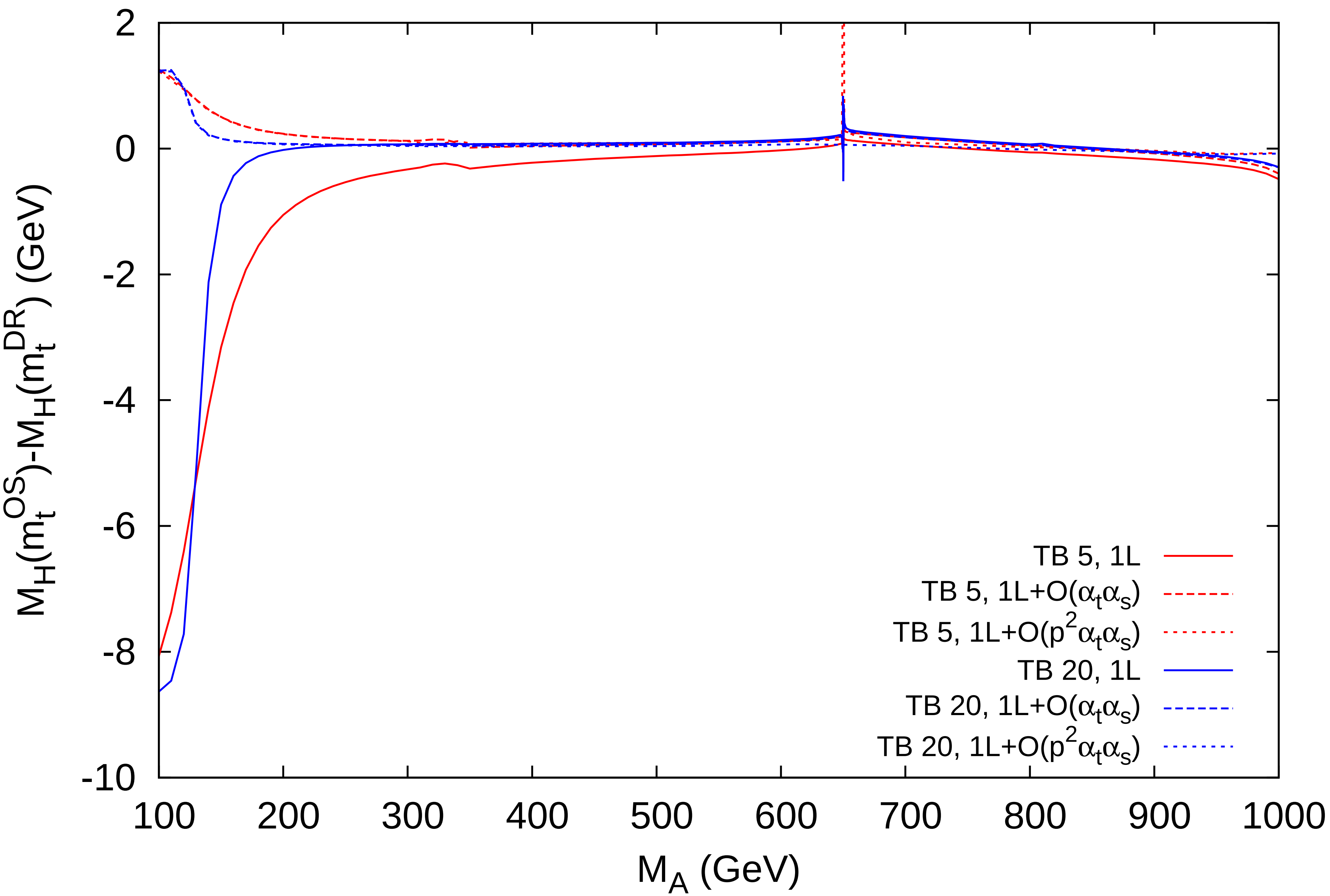


Back-up

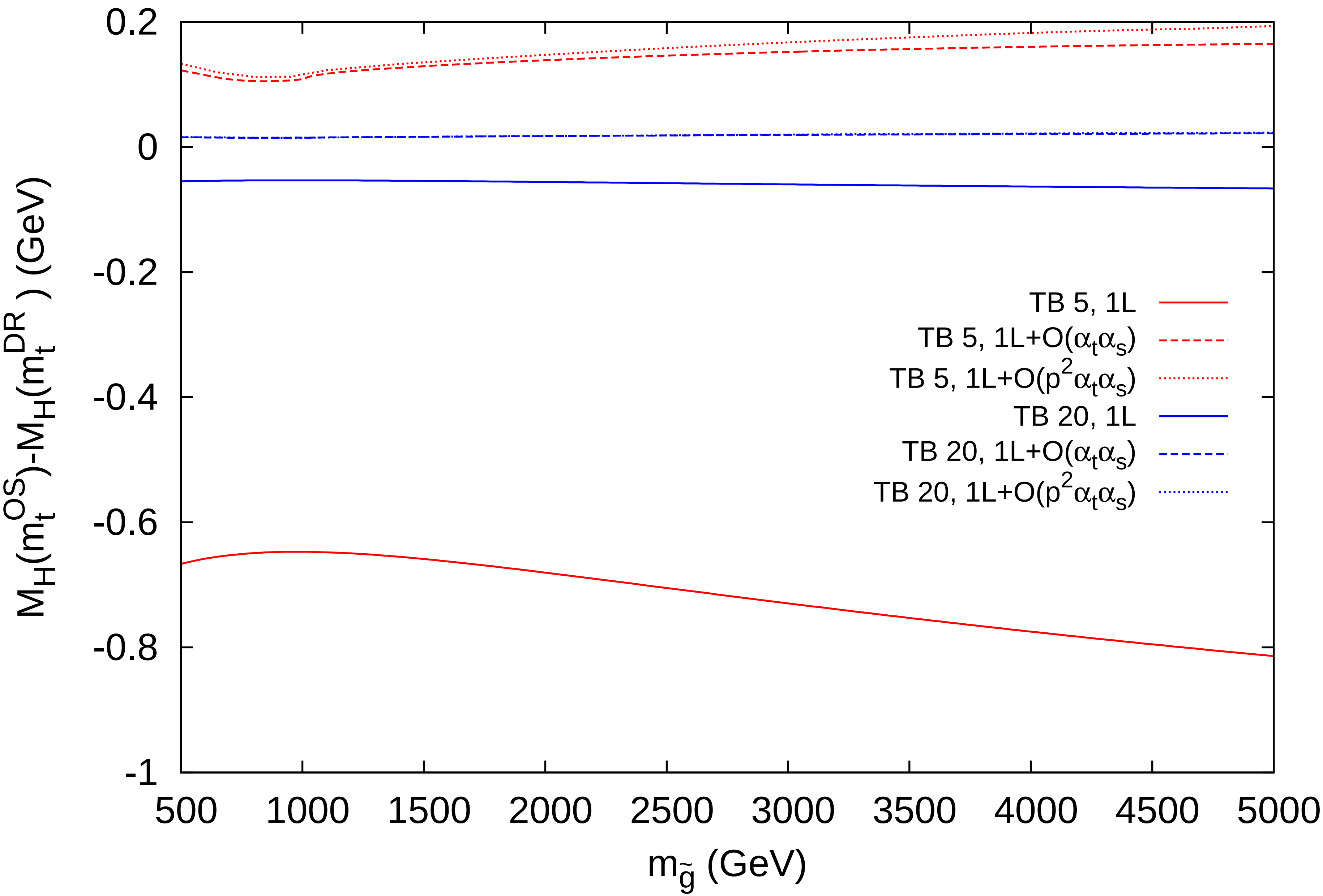
M_A dependence in $m_h^{\rm max}$ scenario:



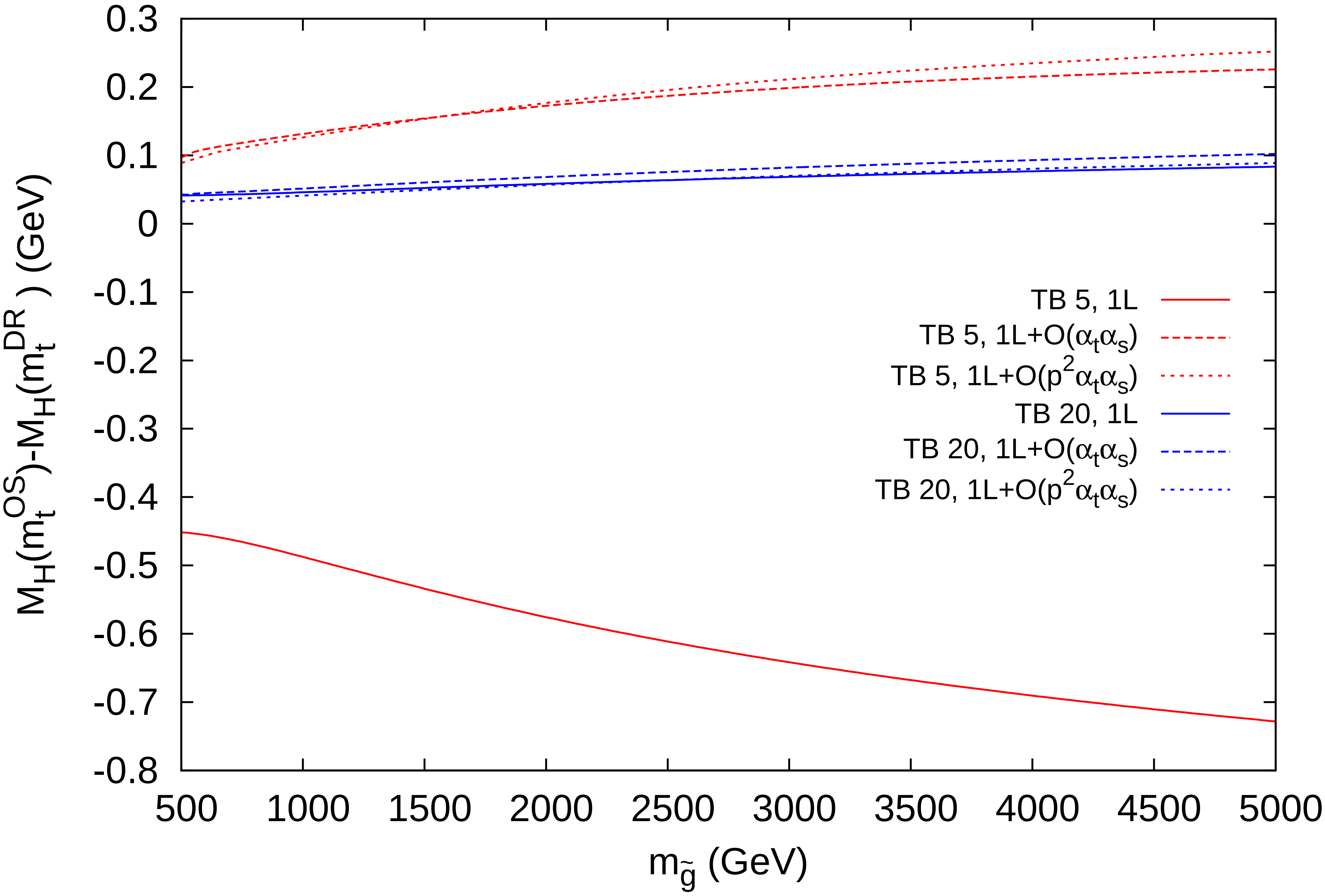
M_A dependence in light-stop scenario:



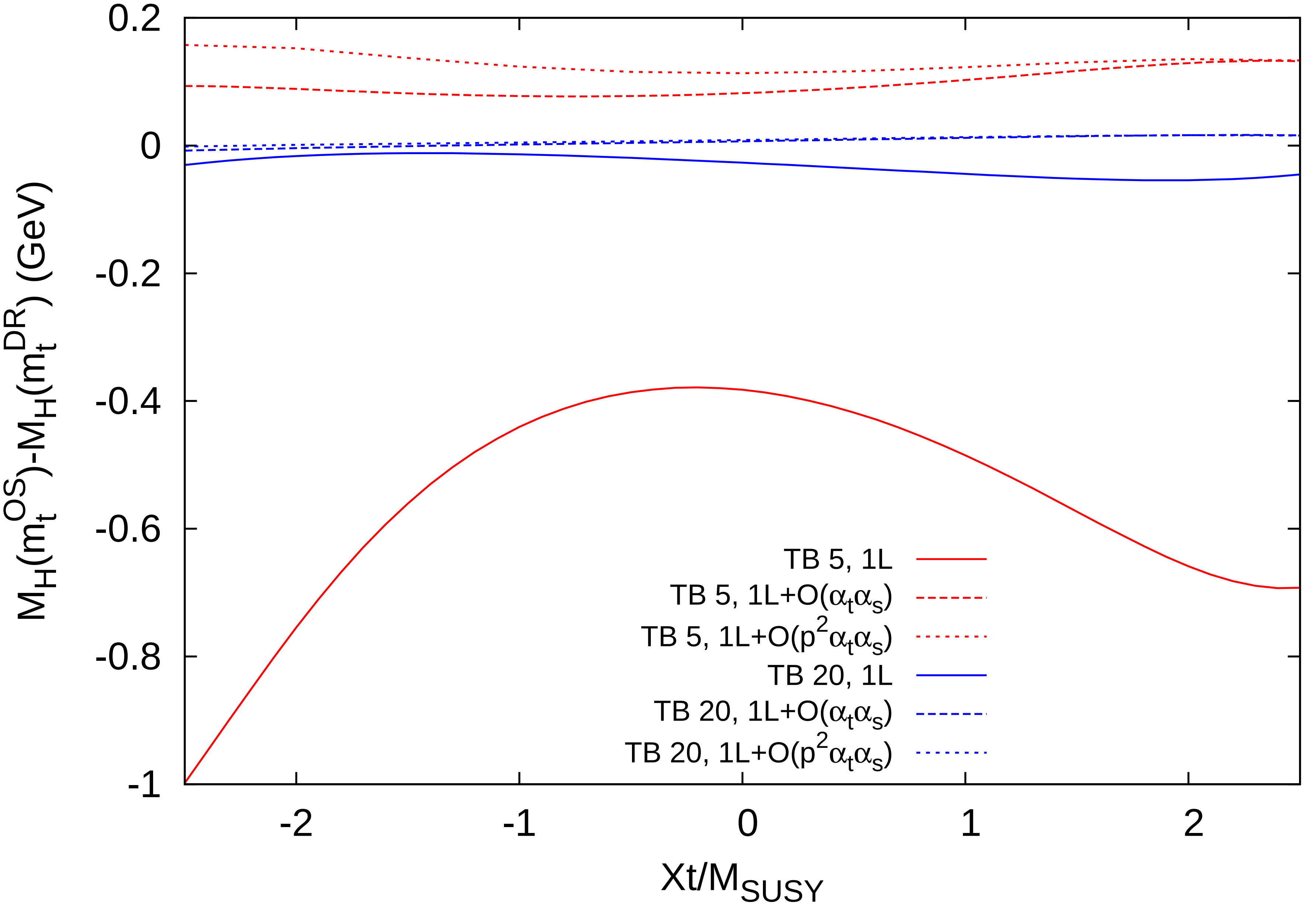
$m_{\tilde{g}}$ dependence in $m_h^{\rm max}$ scenario:



$m_{\tilde{g}}$ dependence in light-stop scenario:



X_t dependence in $m_h^{\rm max}$ scenario:



X_t dependence in light-stop scenario: