

A Fermionic Top Partner

Naturalness and the LHC

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Low fine-tuning \rightarrow Top partners

Two known possibilities:

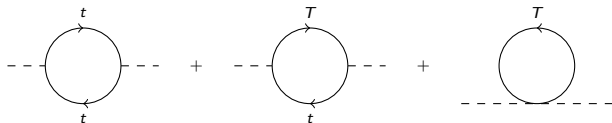
1. Scalar top partner (i.e. SUSY)
 - ▶ Lots of recent papers
2. Fermionic top partner (e.g. Little Higgs)
 - ▶ Our goal: What are the current bounds?

Philosophy: Minimal content for low FT @ 8 TeV LHC

A Minimal Model

- ▶ SM + quarks T_L, T_R with same charges $(3, 1)_{2/3}$
- ▶ Collective symmetry breaking to cancel top loop with minimal $SU(3)/SU(2)$ SSB structure

$$\mathcal{L} \supset -\lambda_t \bar{t}_L H t_R - \lambda_T \bar{t}_L H T_R + \frac{\lambda_t^2 + \lambda_T^2}{2m_T} H^\dagger H \bar{T}_L T_R$$

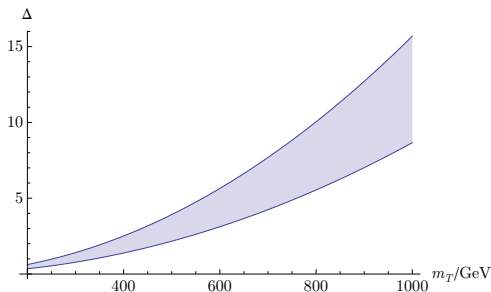


- ▶ 2 new parameters: trade λ_T for RH mixing angle α

Higgs and Fine-tuning

- ▶ Higgs at 125 GeV would mean some fine-tuning:

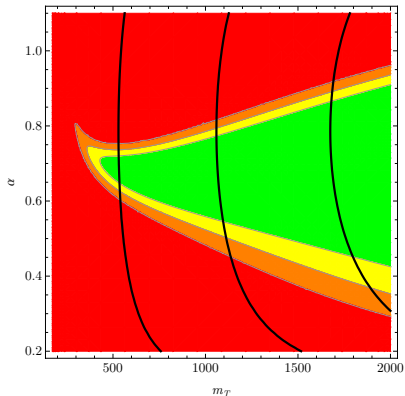
$$\Delta = \frac{|\delta\mu^2|}{\mu_{\text{obs}}^2}$$



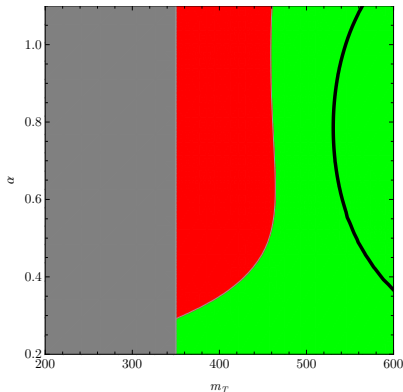
- ▶ Low fine-tuning for $m_T \sim 300$ GeV

Fermionic top partner bounds

Precision Electroweak Fit

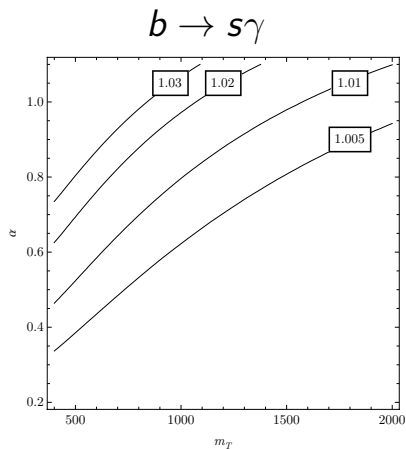
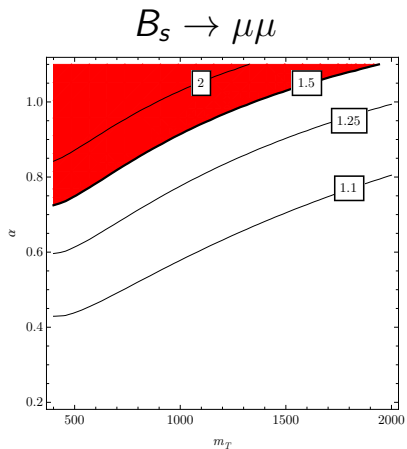


Collider Exclusion



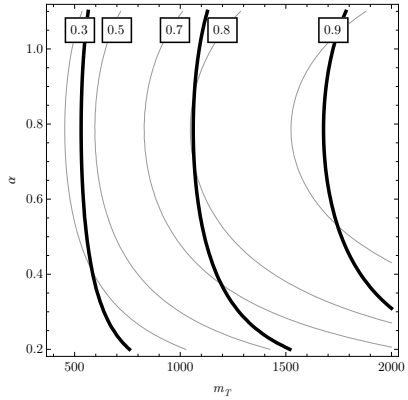
20% fine-tuning allowed!

Flavor bounds

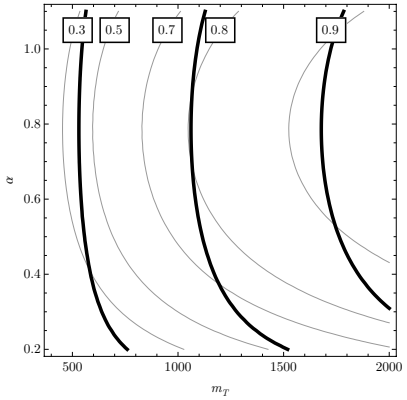


Effect on Higgs Couplings

$h \rightarrow \gamma\gamma$



$h \rightarrow WW$



Status report

- ▶ Top partners are essential for low FT at $\sqrt{s} = 8$ TeV LHC with light Higgs
- ▶ EWPO and collider searches are starting to put significant bounds, but allow 20% fine tuning
- ▶ 2012 could be the year we see top partners!