Probing light stops with stoponium

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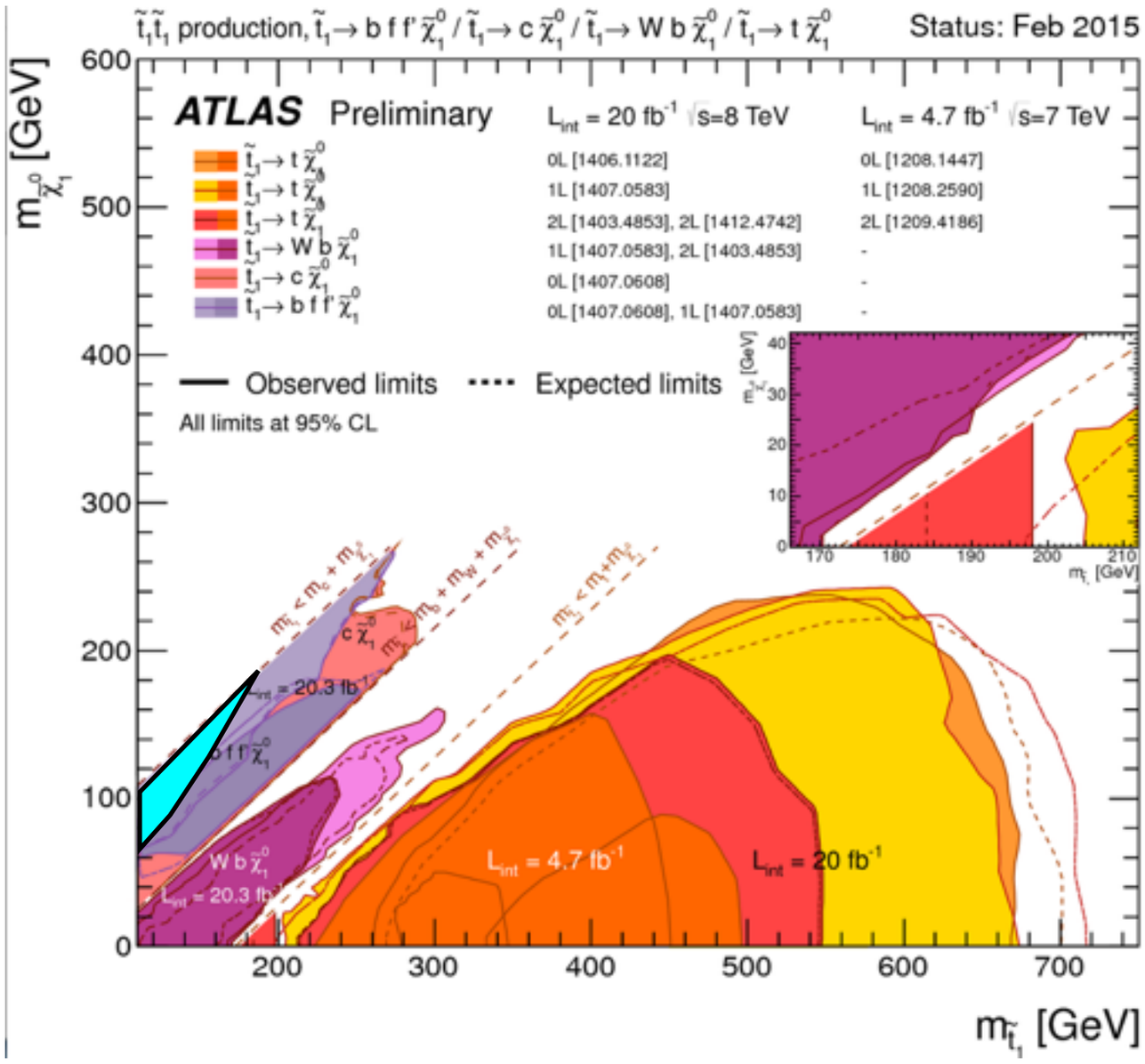
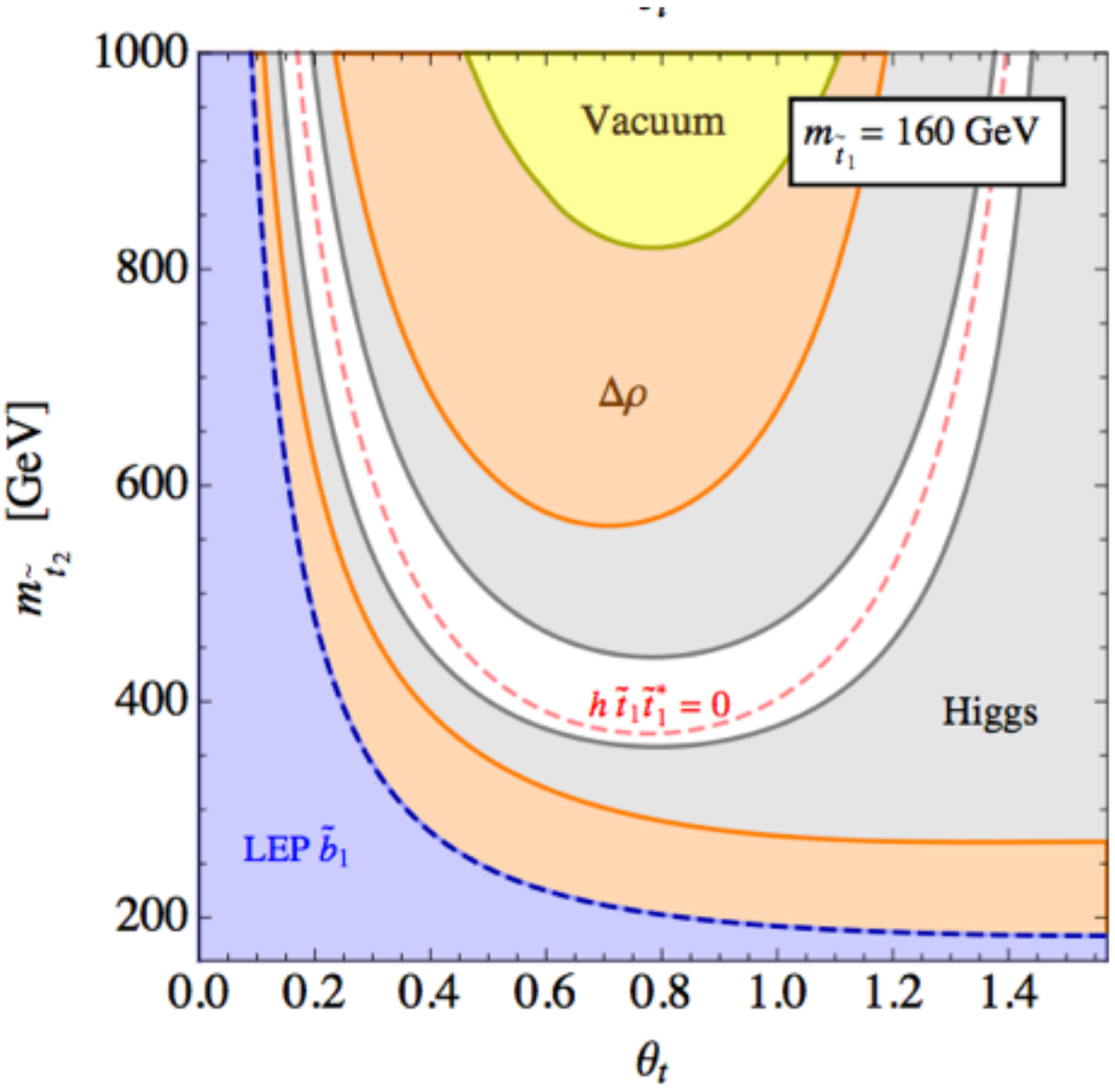
Pheno 2015 @ Univ. Pittsburgh

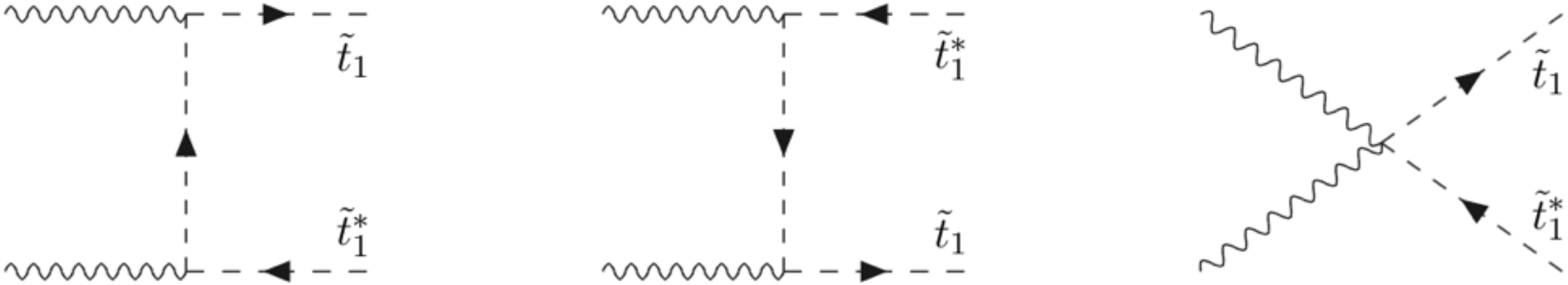
1504.01740 with Brian Batell

Stop blind spots





Production



Diagrams are the same as usual stop pair production, but only in the limit of v->0, or in the threshold region.

$$\sigma(pp \to \eta_{\tilde{t}_1}) \propto \alpha_S^5$$

Annihilation decay

$$pp \to \eta_{\tilde{t}} + X, \quad \eta_{\tilde{t}} \to \gamma\gamma, Z\gamma, WW, ZZ, hh \ldots$$

CP and spin quantum numbers equal to SM Higgs'.

Clean resonance signatures through pair annihilations.
Decay modes are similar to SM Higgs'.

We reinterpret heavy resonance searches to derive new limits on stoponium (hence, light stops).

Uncertainties

~2.0 factor uncertainty from:

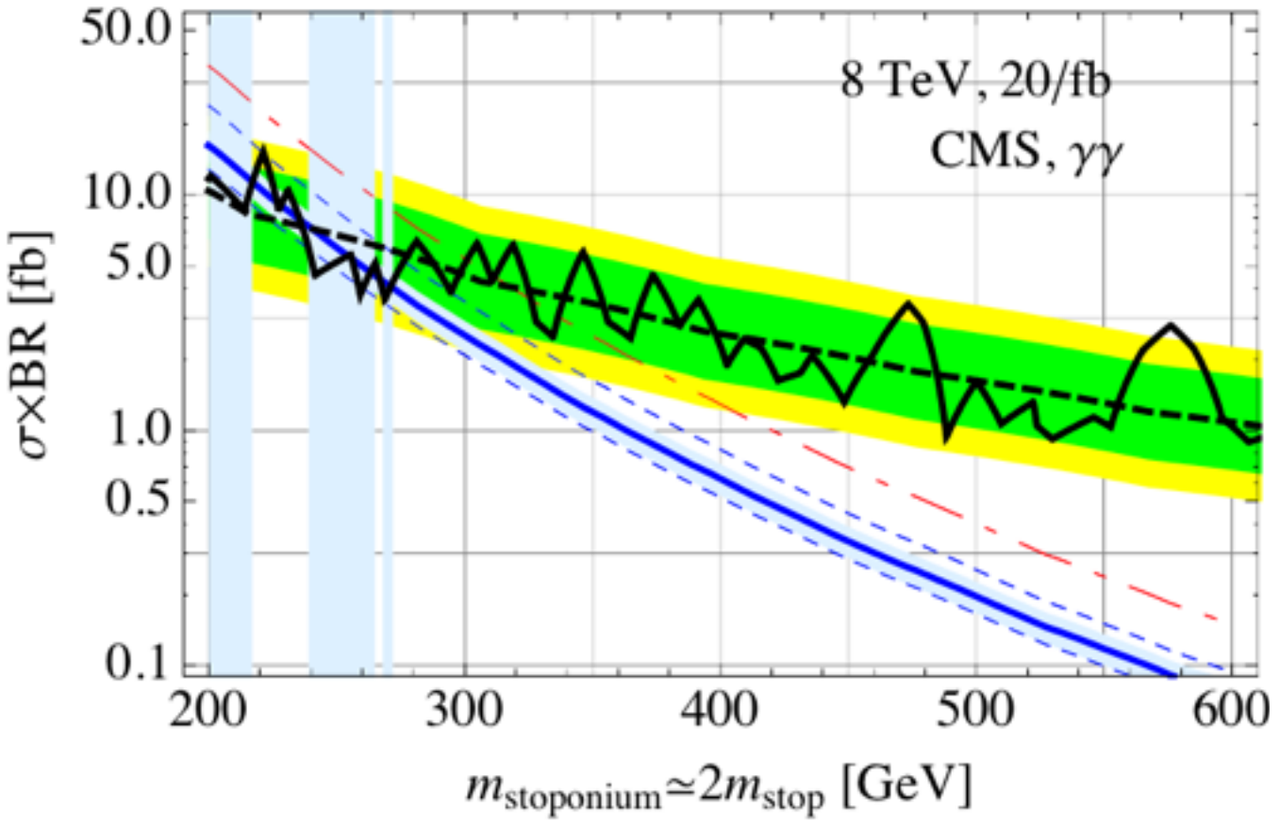
Non-perturbative potential model dependencies:
Coulomb vs. charmonium-inspired

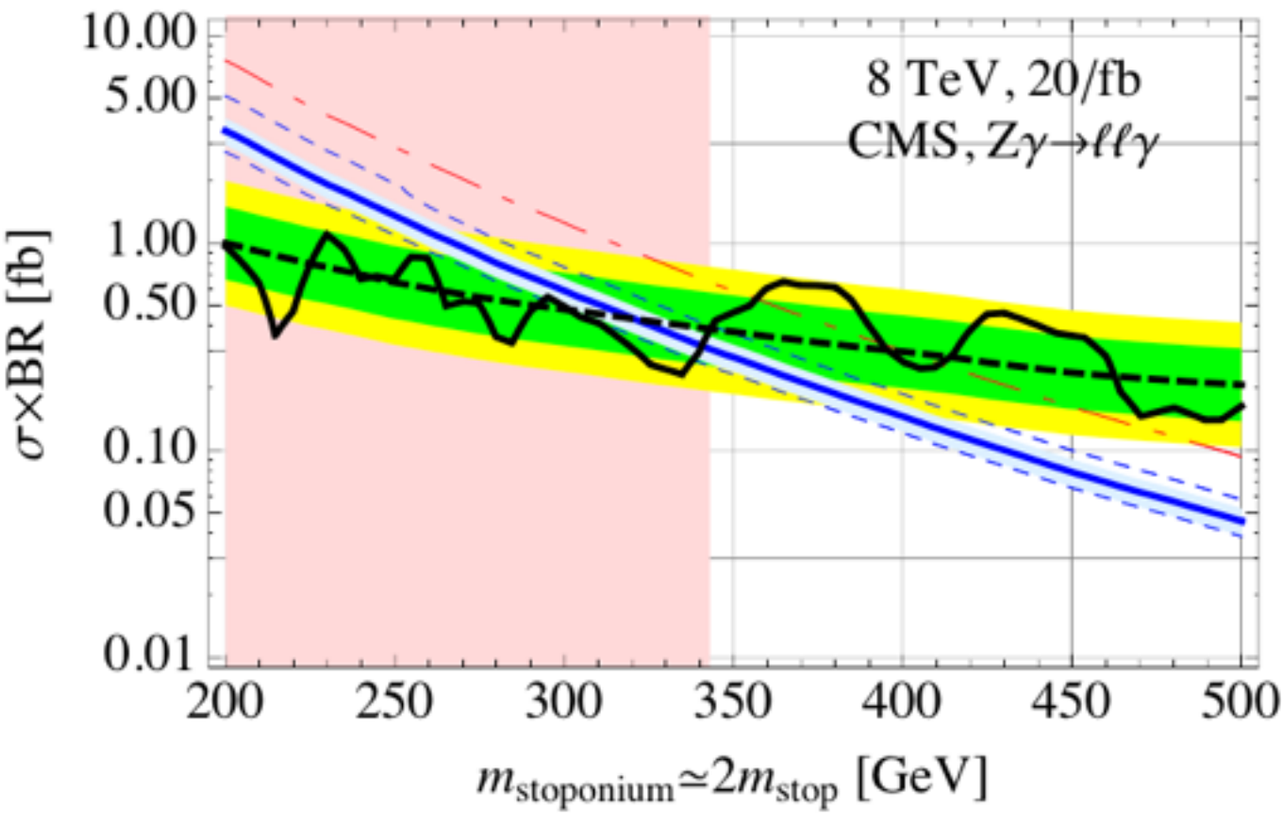
~1.5 factor uncertainty from:

Not only ground state 1S, but also excited S-wave states can contribute to signal.

Diphoton and Zgamma

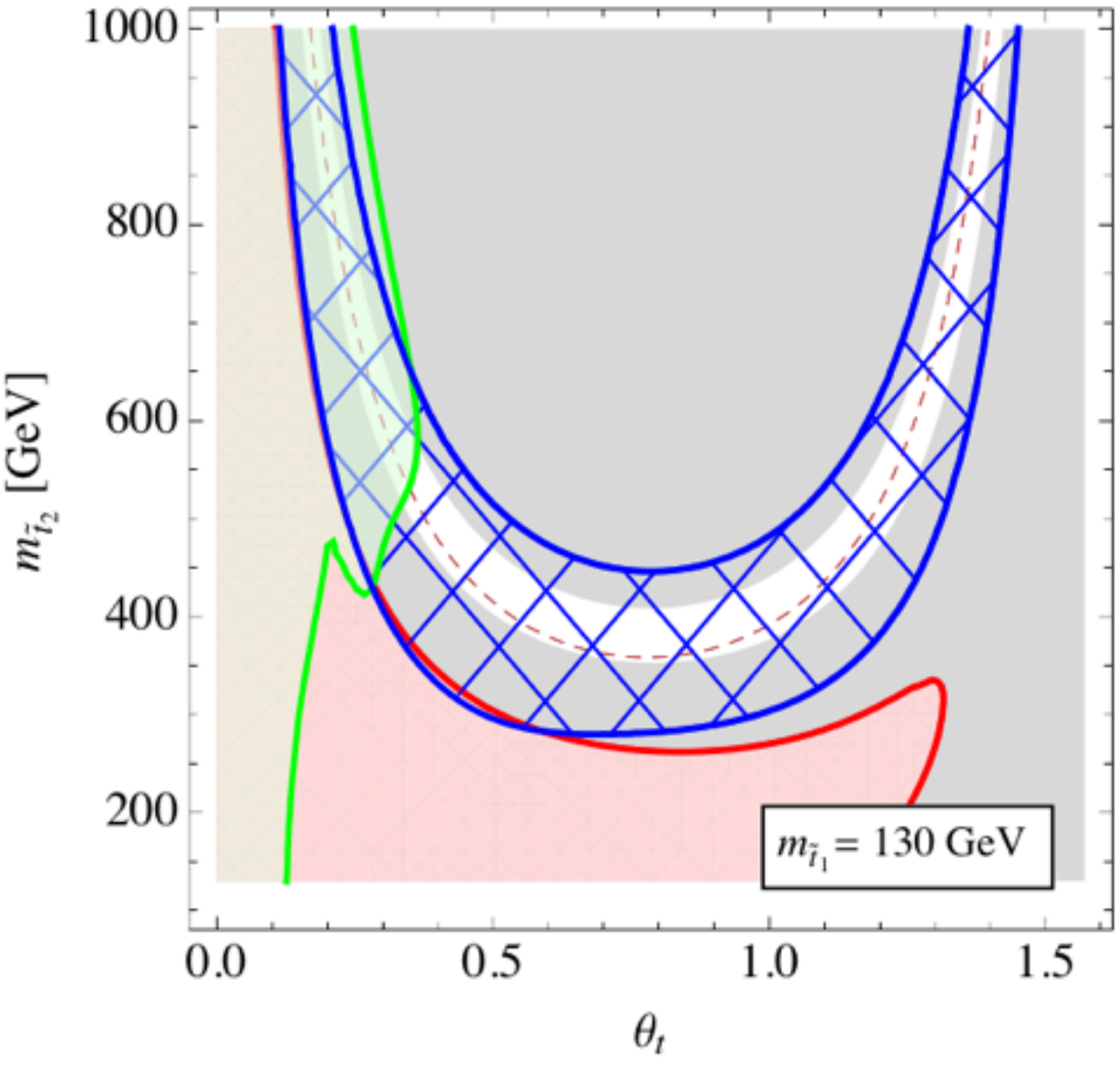
Assuming stoponium forms and decays…

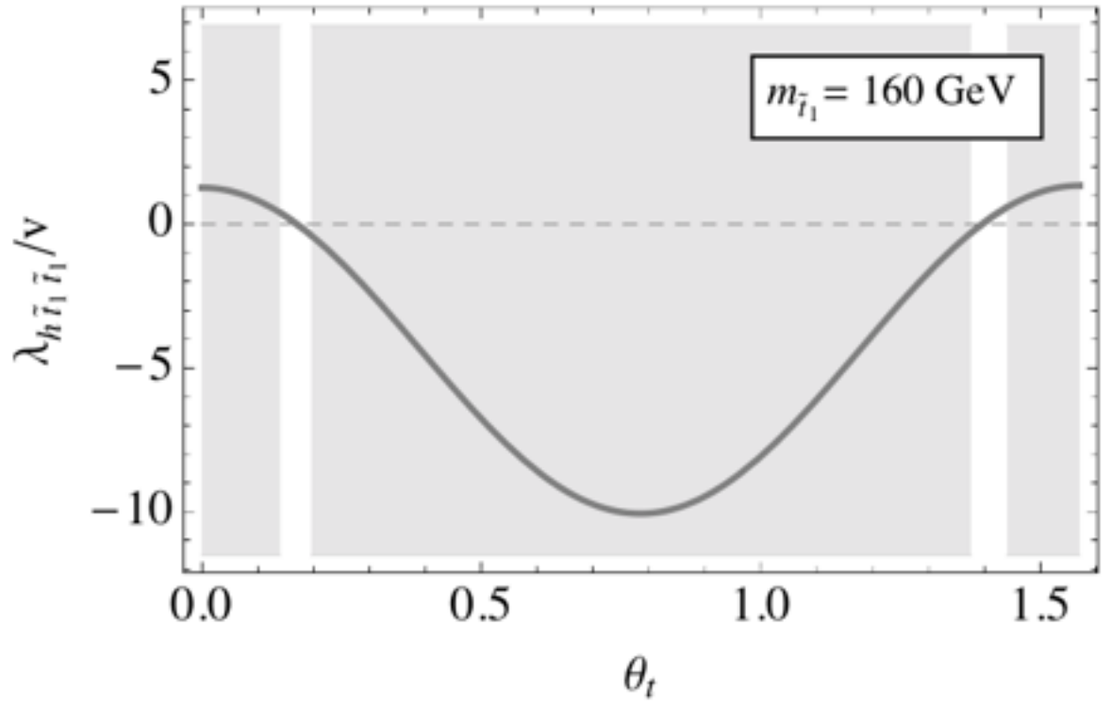


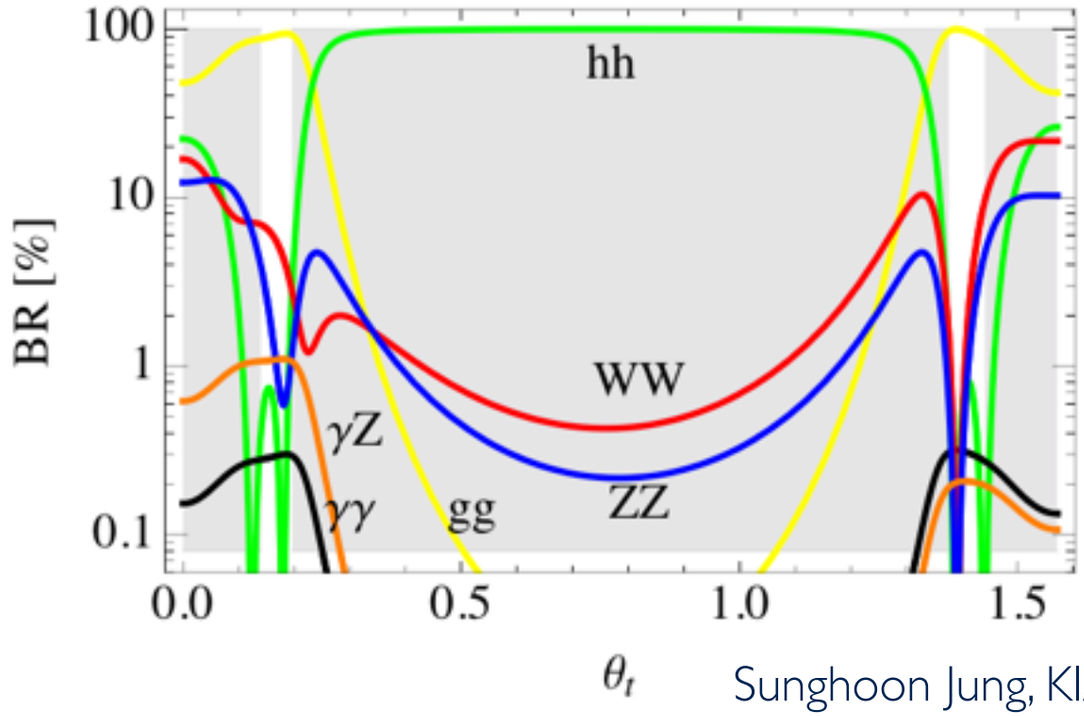


ideal(maximal) BRs

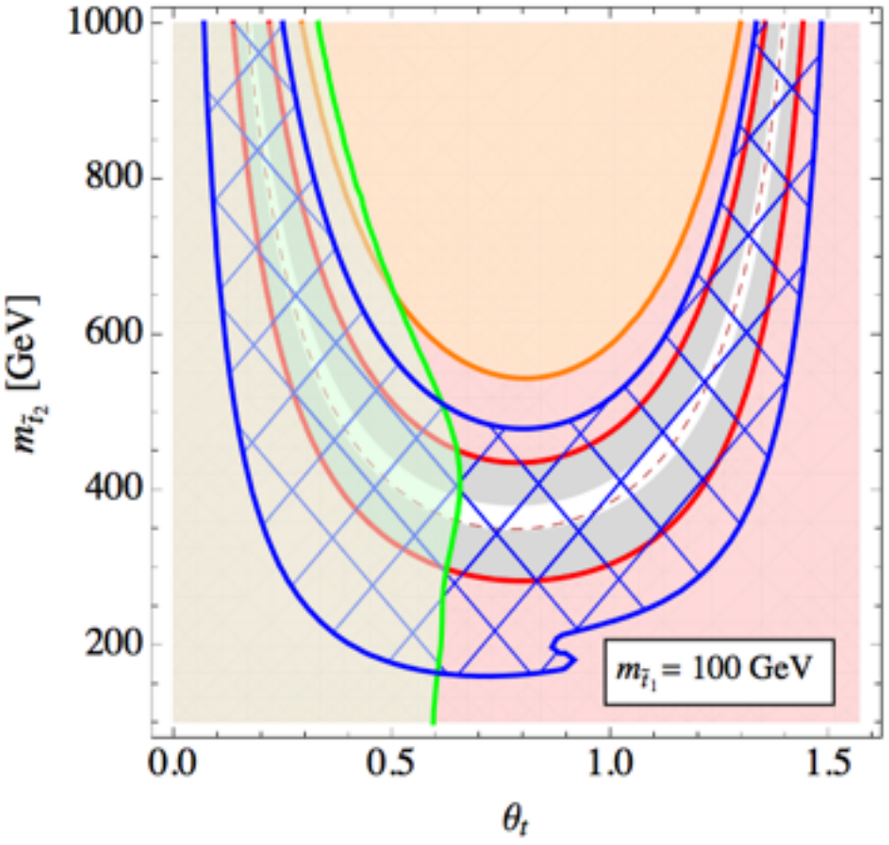
Results: Interplay

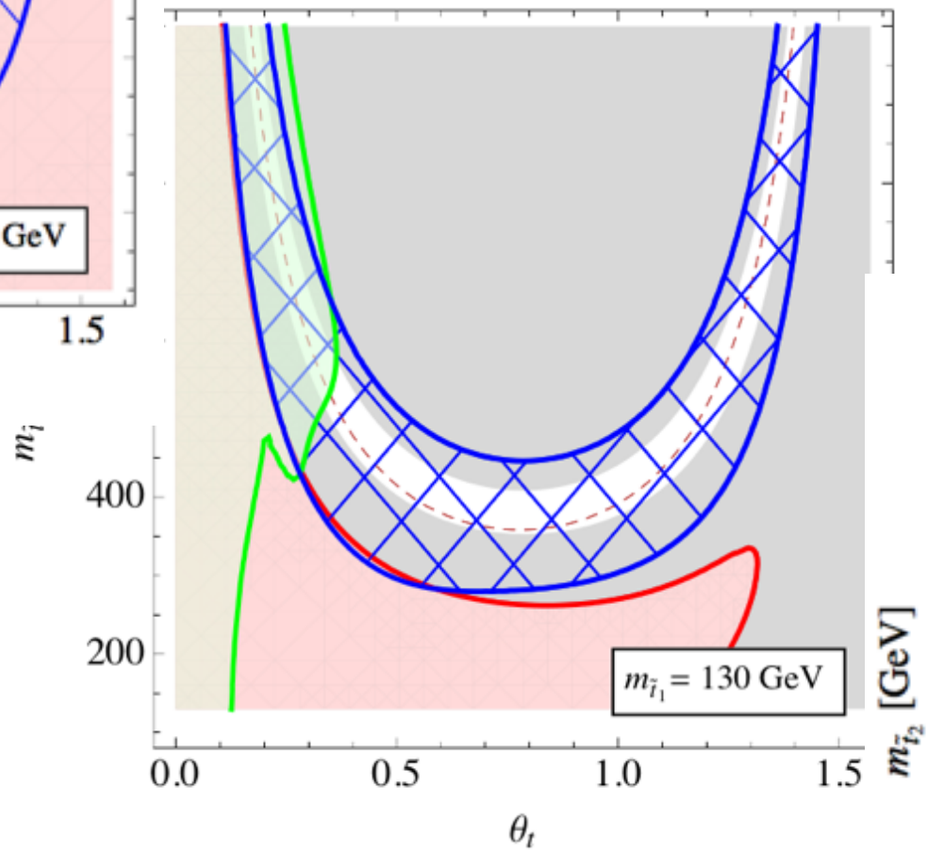






Results: Interplay



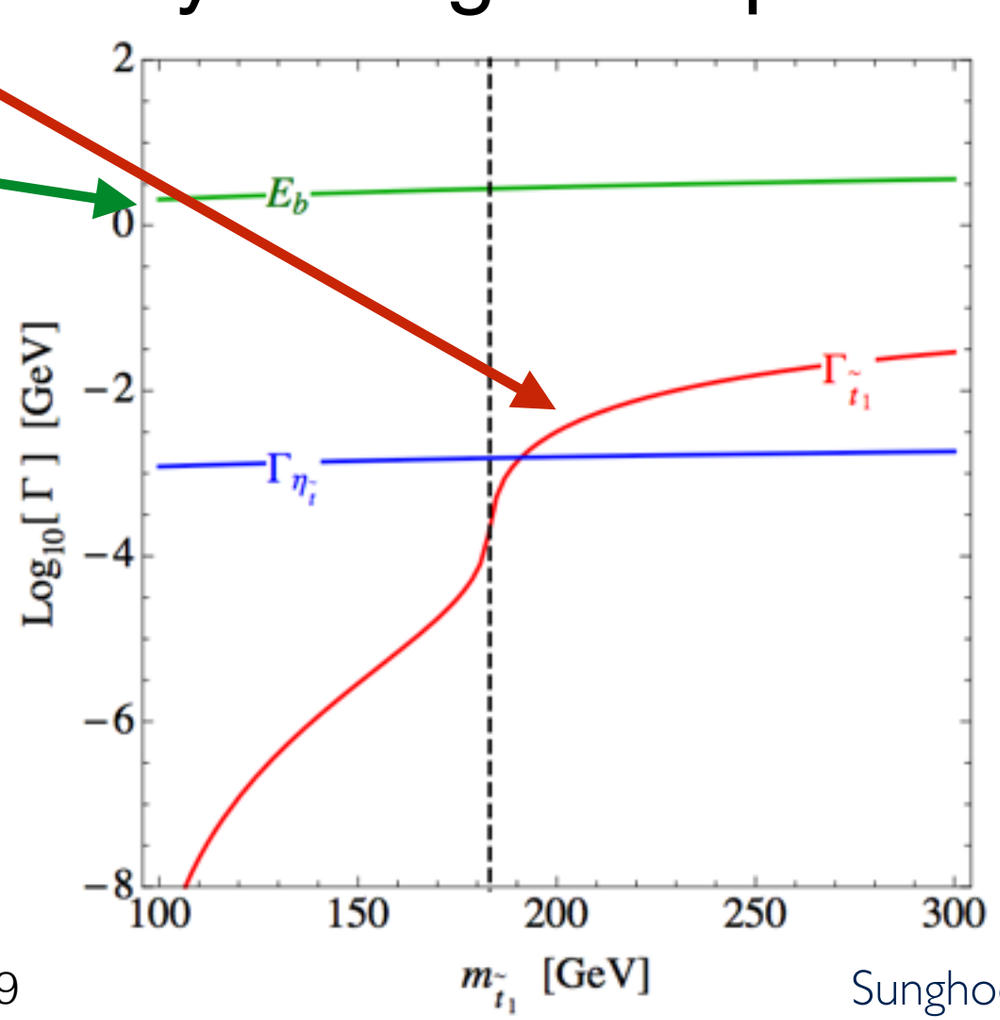


Stoponium formation conditions

- When the stop and anti-stop are produced with a small relative velocity: only near stop pair threshold.

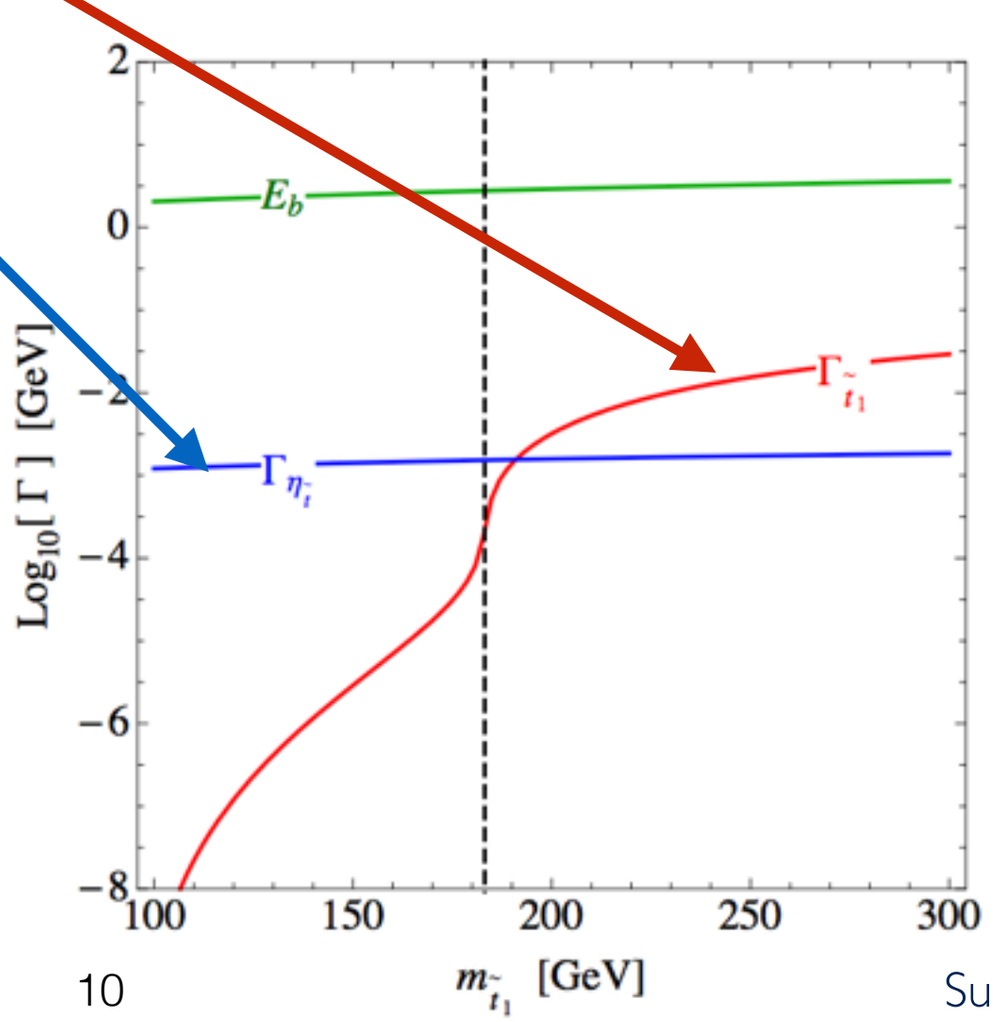
- When the stop decay is slowly enough compared to the binding time scale.

(NB: the toponium has not been observed!)

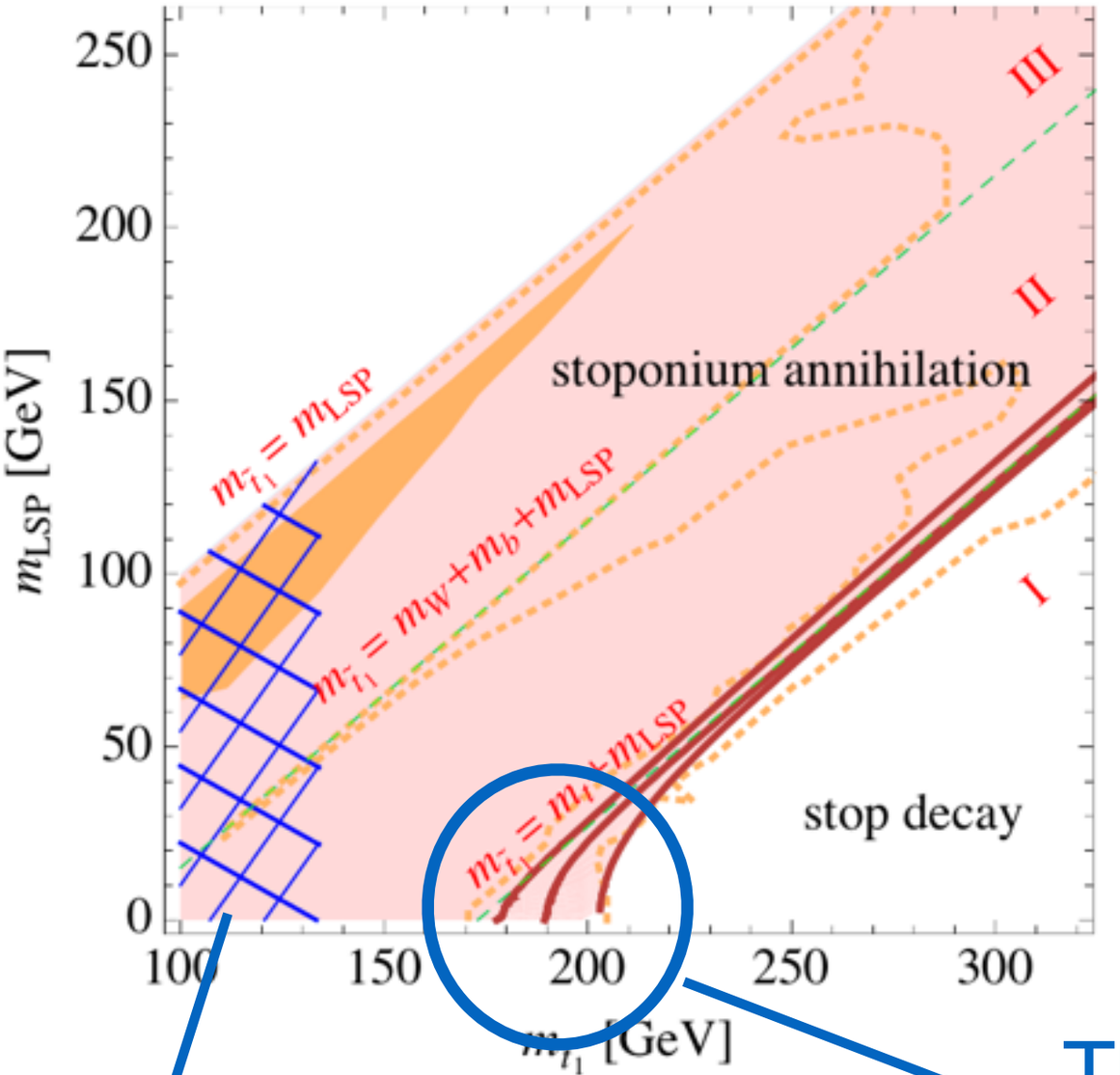


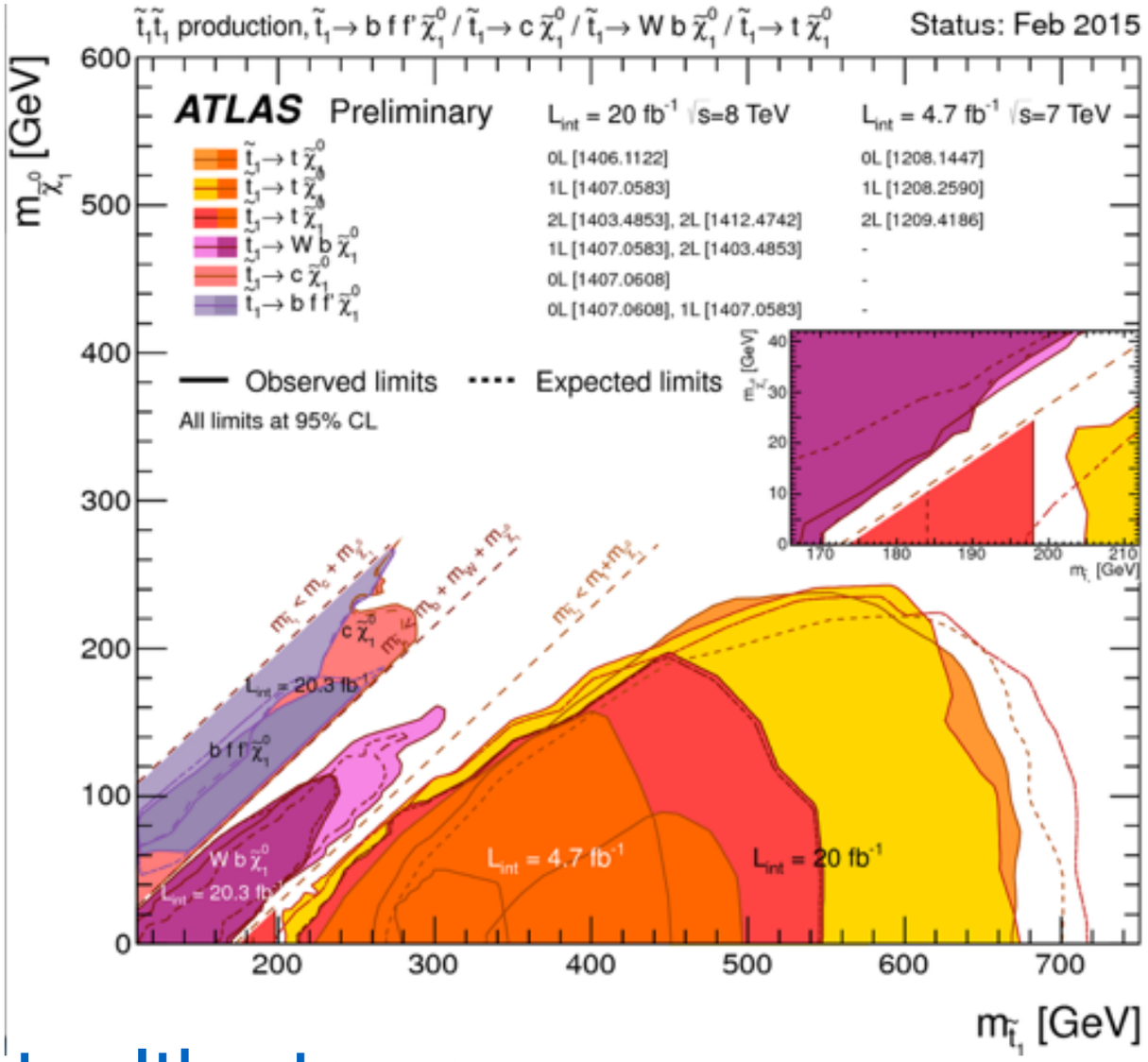
Stoponium annihilation conditions

- Annihilation is what makes it look like a resonance.
- Individual stop decay should be slower than stoponium annihilation. Crucial condition for stoponium pheno.



Stoponium coverage - RPC

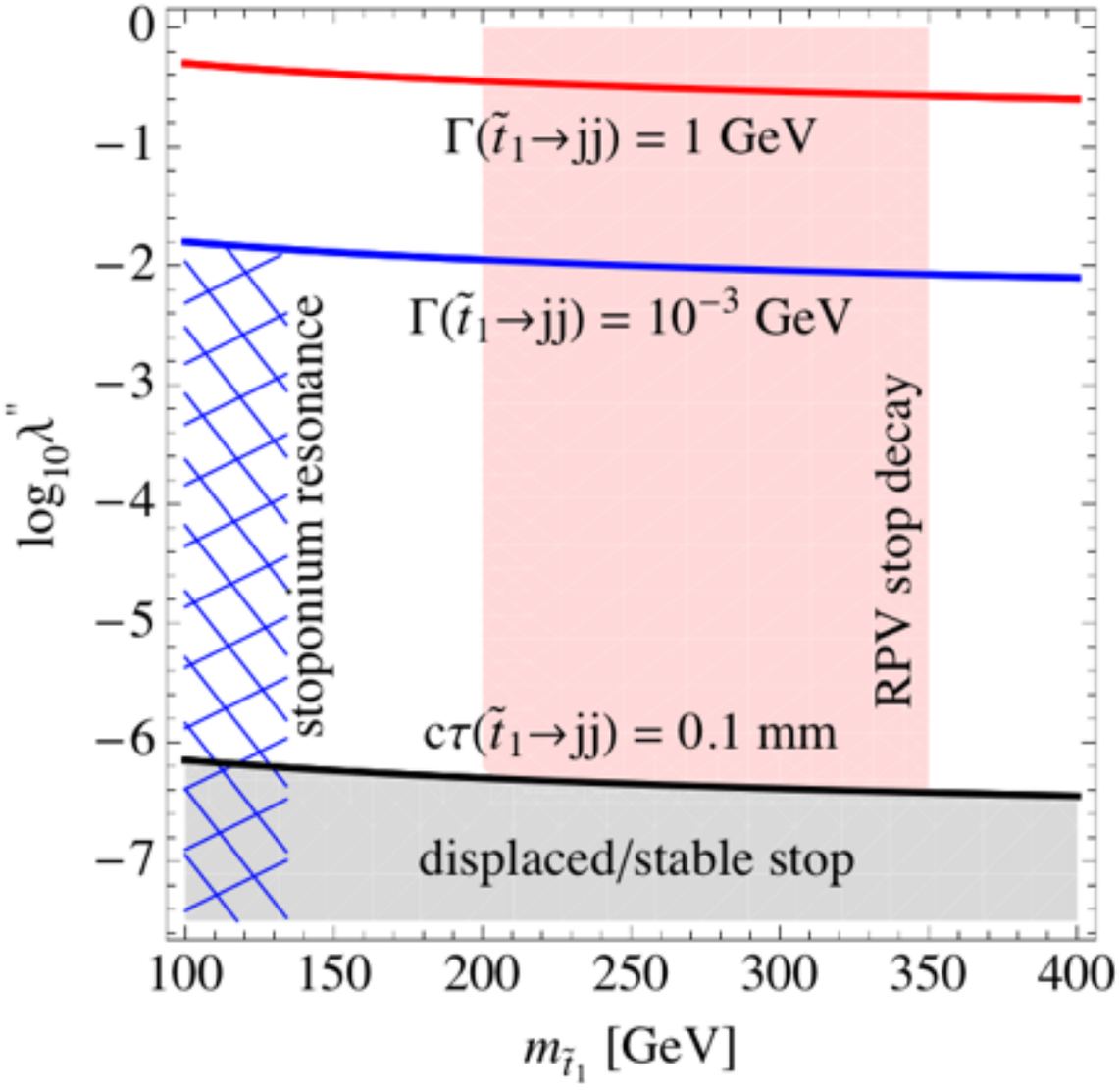




current bounds

The stealth stop can also be probed!

Coverage - RPV model



Summary

- Highly complementary to direct searches and Higgs/ electroweak precision probes.
- Clean/unambiguous resonance searches: diphoton, Zgamma, ZZ, hh, ttbar
- Covering RPC and RPV uncoverd parameter space.
- Uncertainties from potential model and excited states shall be improved (lattice maybe relevant).