Flavour vs LHC squark limits

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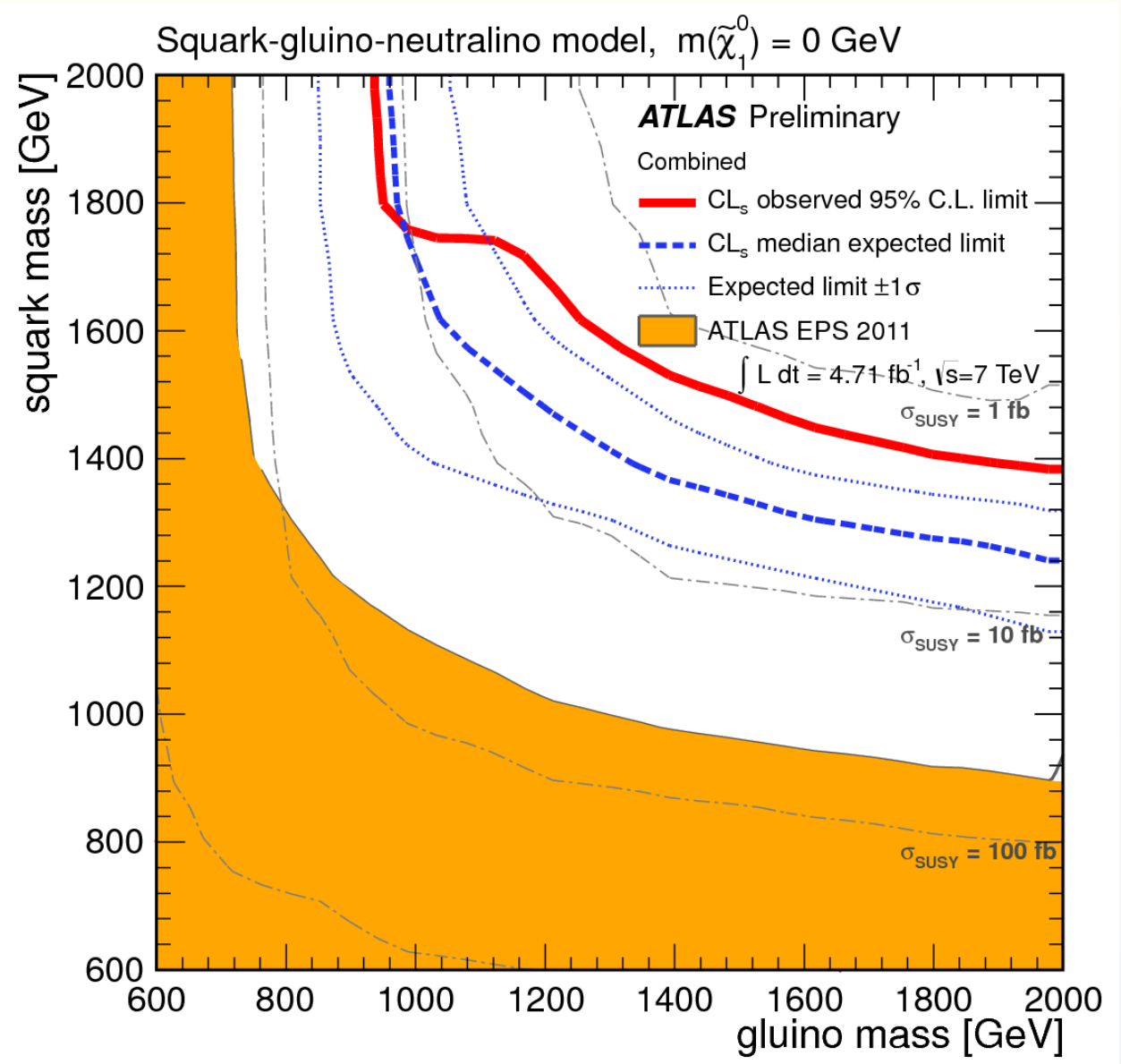
Work in progress with Michele Papucci, Gilad Perez, Josh Ruderman, Andi Weiler

The relentless march of experiment



Are squarks below 1 TeV ruled out?

What assumptions underlie searches? Are they justified?

Ways out?

- RPV
- squeezed spectra
- stealth scenarios
- light stops
- non-degenerate light squarks?

Naive argument

Not allowed by flavour constraints Isidori, Nir, Perez 1002.0900

Operator	Bounds on Λ in TeV ($c_{ij} = 1$) Re	Im	Bounds on c_{ij} ($\Lambda = 1$ TeV) Re	Im	Observables
$(\bar{s}_L\gamma^\mu d_L)^2$	9.8×10^2	1.6×10^4	9.0×10^{-7}	3.4×10^{-9}	Δm_K; ϵ_K
$(\bar{s}_R\, d_L)(\bar{s}_L d_R)$	1.8×10^4	3.2×10^5	6.9×10^{-9}	2.6×10^{-11}	Δm_K; ϵ_K
$(\bar{c}_L\gamma^\mu u_L)^2$	1.2×10^3	2.9×10^3	5.6×10^{-7}	1.0×10^{-7}	Δm_D; $\lvert q/p\rvert, \phi_D$
$(\bar{c}_R\, u_L)(\bar{c}_L u_R)$	6.2×10^3	1.5×10^4	5.7×10^{-8}	1.1×10^{-8}	Δm_D; $\lvert q/p\rvert, \phi_D$
$(\bar{b}_L\gamma^\mu d_L)^2$	5.1×10^2	9.3×10^2	3.3×10^{-6}	1.0×10^{-6}	Δm_{B_d}; $S_{\psi K_S}$
$(\bar{b}_R\, d_L)(\bar{b}_L d_R)$	1.9×10^3	3.6×10^3	5.6×10^{-7}	1.7×10^{-7}	Δm_{B_d}; $S_{\psi K_S}$
$(\bar{b}_L\gamma^\mu s_L)^2$	1.1×10^2		7.6×10^{-5}		Δm_{B_s}
$(\bar{b}_R\, s_L)(\bar{b}_L s_R)$	3.7×10^2		1.3×10^{-5}		Δm_{B_s}

To satisfy flavour bounds squarks must either:

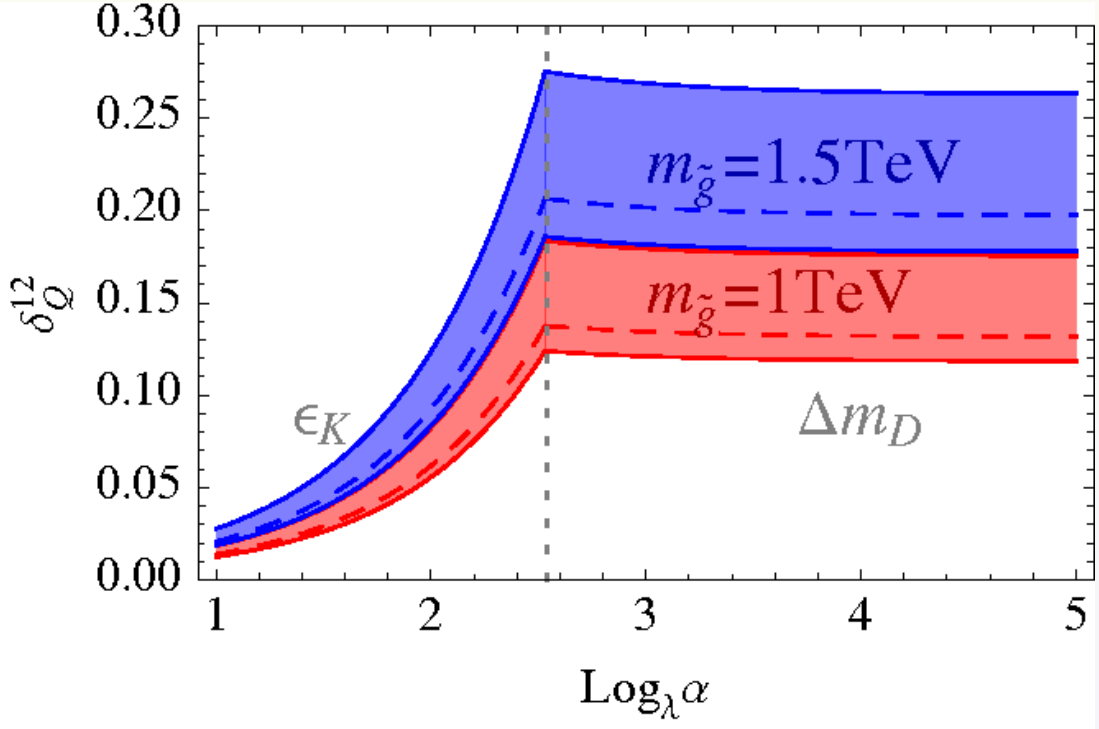
- be heavy
- have small mixings
- be degenerate

Not-so-naive argument

Alignment

Left-handed squarks can be optimally aligned so as to minimize flavour constraints. Nir, Seiberg hep-ph/9304307

CP violation constraints universal Gedalia et al, 1202.5038



E.g.

$$m_{\tilde{g}} = 1 \text{ TeV}$$

$$m_{\tilde{Q}1} = 550 \text{ GeV}$$
$$m_{\tilde{Q}2} = 950 \text{ GeV}$$

L-H squarks splitting dependent on gluino mass, R-H squarks arbitrarily split

How do limits change?

Estimate:

$$\sigma \sim \frac{1}{m_{\tilde{q}}^5}$$

Decouple 6 dof:

$$\Rightarrow \frac{\Delta m_{\max}}{m_{\max}} = 1 - 4^{-\frac{1}{5}} \sim 25\%$$

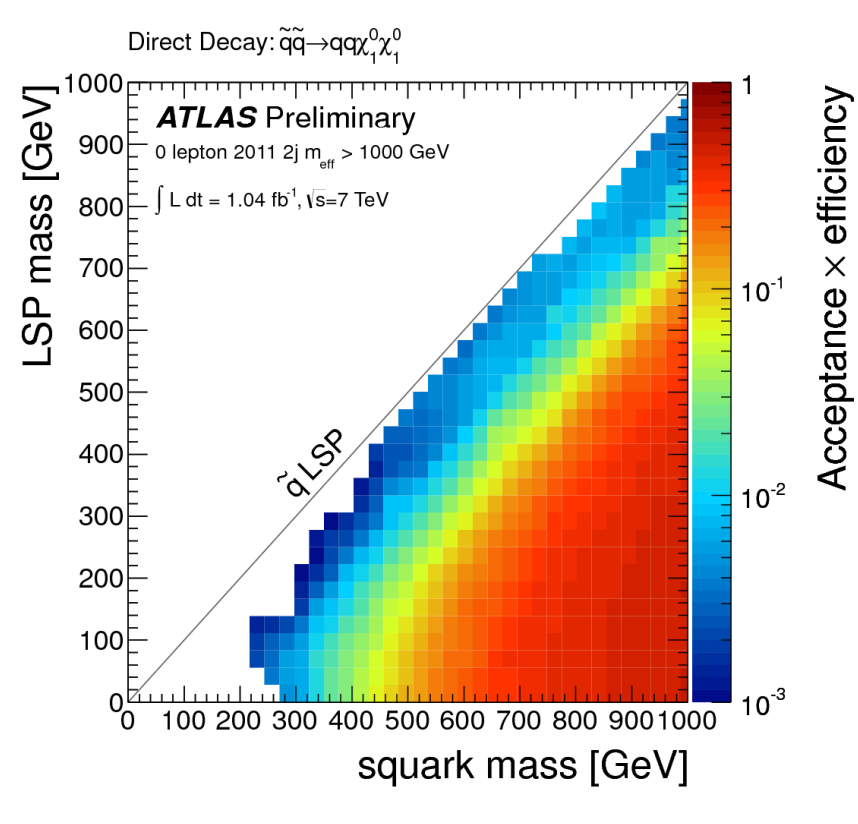
TOO NAIVE!

Limits affected by:

- squark multiplicity
- signal efficiencies
- PDFs

Efficiencies

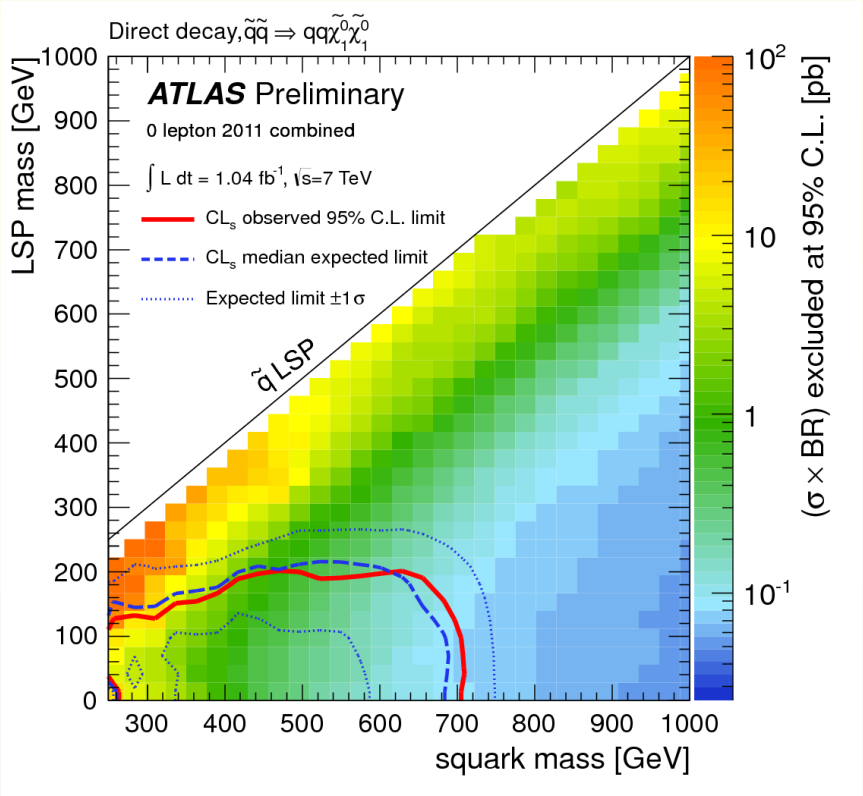
Signal efficiency falls very rapidly with decreasing squark mass



Below $\sim$ 600 GeV $\epsilon\sigma = 1$

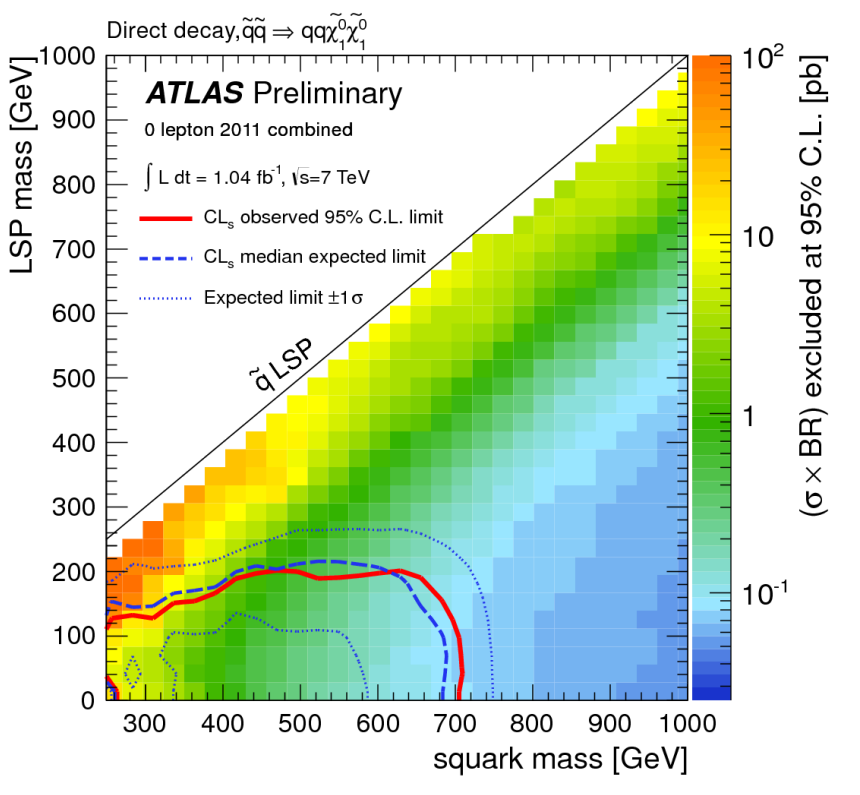
Theorist recipe for limit-setting

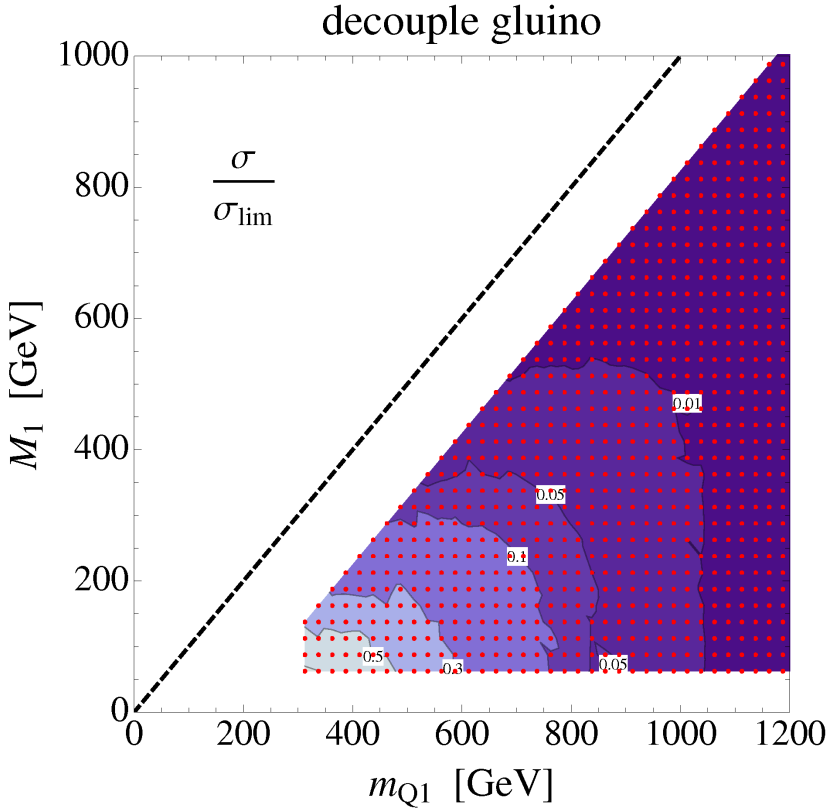
simplifiedmodelfeynman.pdf



- Take relevant simplified model analysis (for 1 fb^{-1})
- Compute cross section at each parameter point
- Convolve with efficency $\times$ acceptance (provided by experiment)
- Compare with excluded cross section

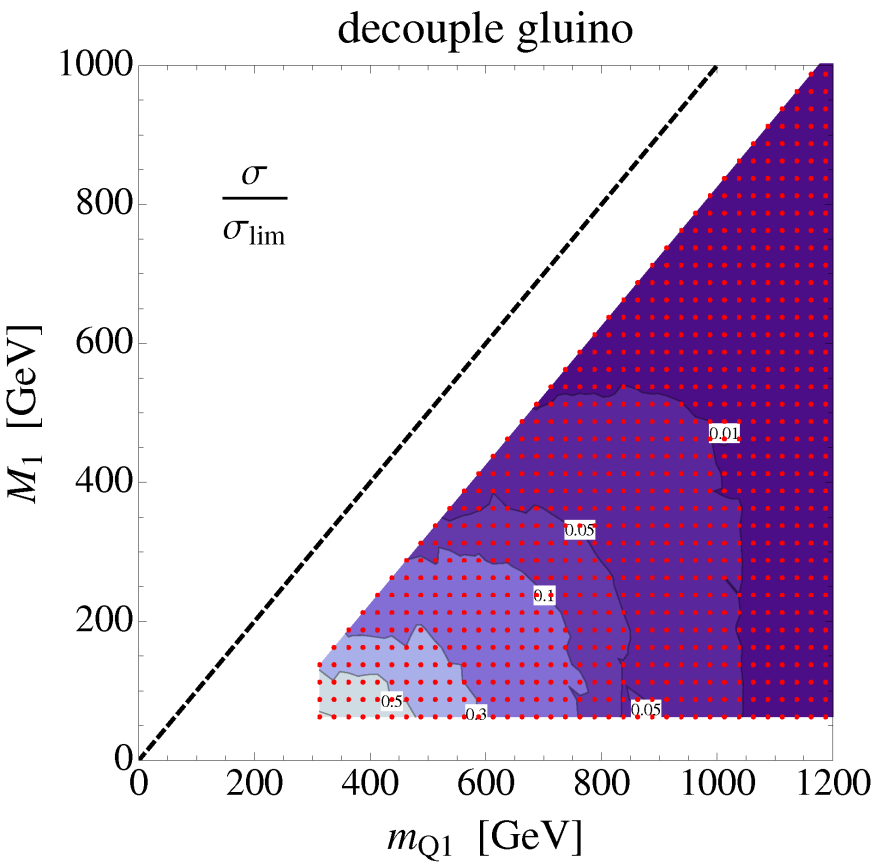
Effect of efficiency

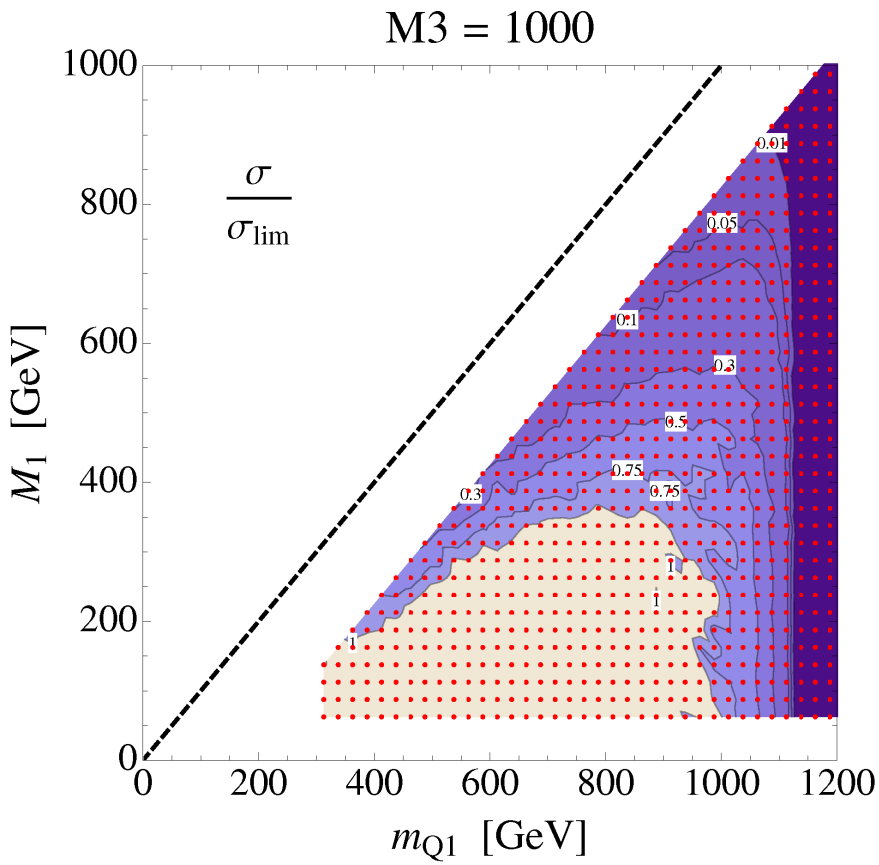




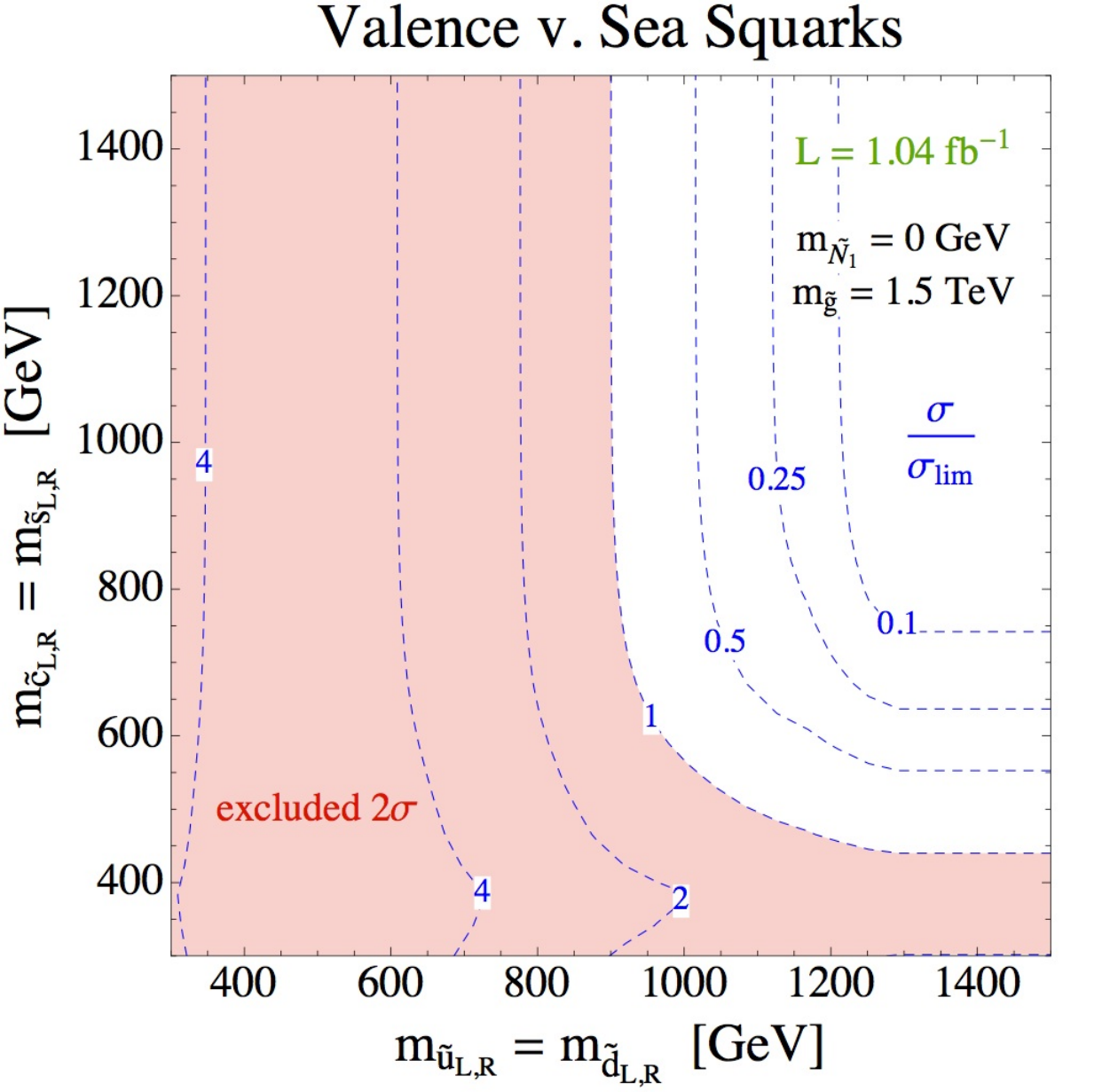
No limit!

Effect of PDF

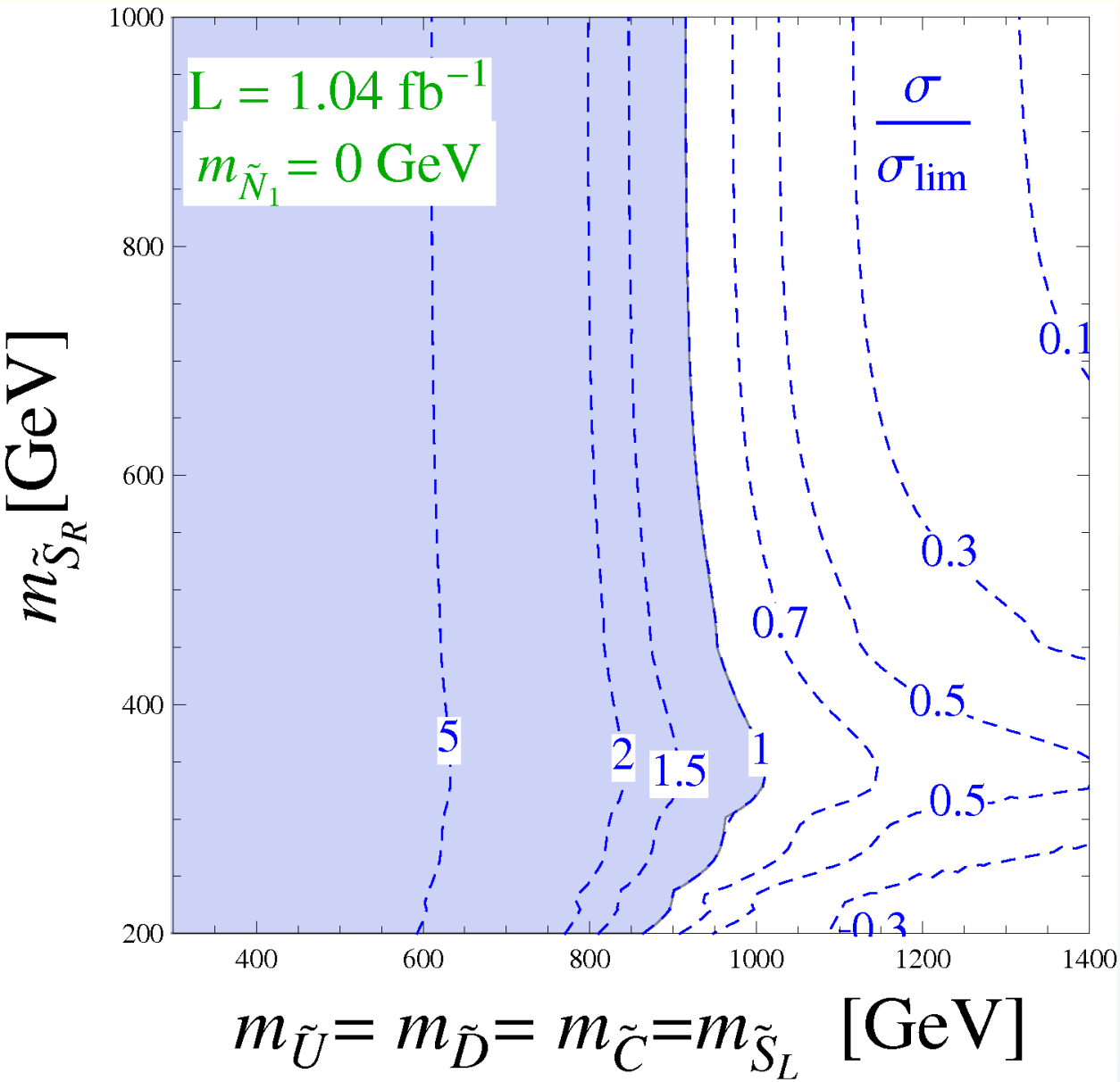




Undecoupled 1st generation



Undecoupled 1st generation



Conclusions

- 1st and 2nd generation squark limits are very sensitive to the assumption of degeneracy
- There is a hole in the experimental net for light 2nd generation squarks - esignated searches?
- To do: extend analysis to 5 fb^{-1}: wait for efficiency maps / generate + validate ourselves?