MSSM Prospects in $B \to \mu^+\mu^-$ at low $\tan\beta$

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IOP Institute of Physics

High Energy Particle Physics Group Meeting
Lancaster, 2 April 2008

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What you should know

- **Usual motivation:** hierarchy, unification, dark matter, ...
- Many high-scale models, unique TeV model: **MSSM**
- Two Higgs doublets, $H_{u,d}$. Each gets a vev.
- Ratio of these vevs is a free parameter: $\tan\beta \equiv v_u/v_d$

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Caveat: Flavour experiments are sensitive to any new physics. Particular models (e.g. SUSY) need to be confirmed by the LHC+ILC.

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We want to look for new physics in **B mesons**

Meson	Mass	Mean lifetime
B_d^0	5.28 GeV	1.53×10^{-12}s
B_s^0	5.37 GeV	1.44×10^{-12}s

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- ... i.e. look at loop diagrams.
- ... namely **penguin diagrams**

Where does one look for penguins?

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Antarctica: very little background, penguin is dominant.

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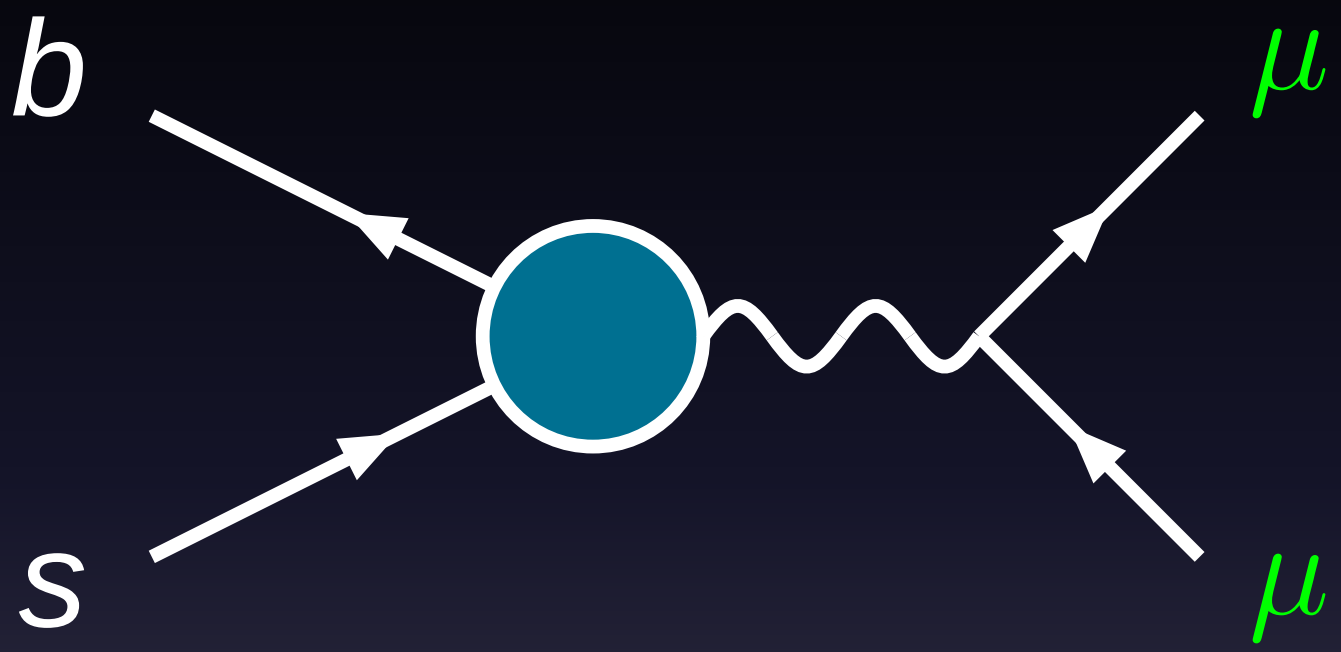

$B \to \mu^+\mu^-$: very little background, penguin is dominant.

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Standard Model suppressed by....

- **Loop**: no tree-level contribution
- **FCNC**: $|V^* V|_{bs}$
- **Helicity**: Angular momentum $\Rightarrow$ $\mathcal{M} \propto m_\mu$

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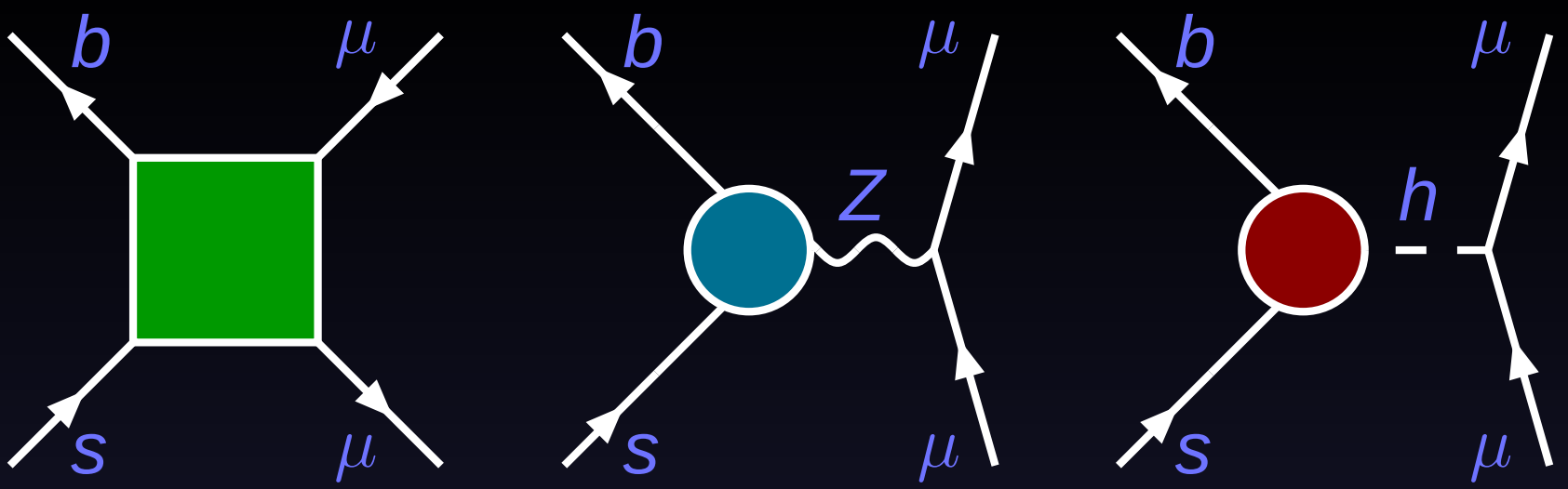
Experimentally clean: final state is very easy to tag in a detector.

Theoretically clean: the only hadronic uncertainties come from f_{B_s}

Current experimental bounds and SM expectations

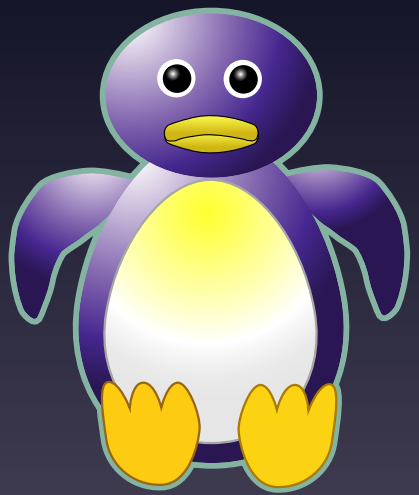
Channel	Expt.	Bound (90% CL)	SM Prediction
$B_s^0 \to \mu^+\mu^-$	CDF II	$< 4.7 \times 10^{-8}$	$(4.817 \pm 0.017) \times 10^{-9}$
$B_d^0 \to \mu^+\mu^-$	CDF II	$< 1.5 \times 10^{-8}$	$(1.903 \pm 0.006) \times 10^{-10}$
$B_s^0 \to \mu^+ e^-$	CDF	$< 6.1 \times 10^{-6}$	≈ 0
$B_d^0 \to \mu^+ e^-$	BABAR	$< 9.2 \times 10^{-8}$	≈ 0

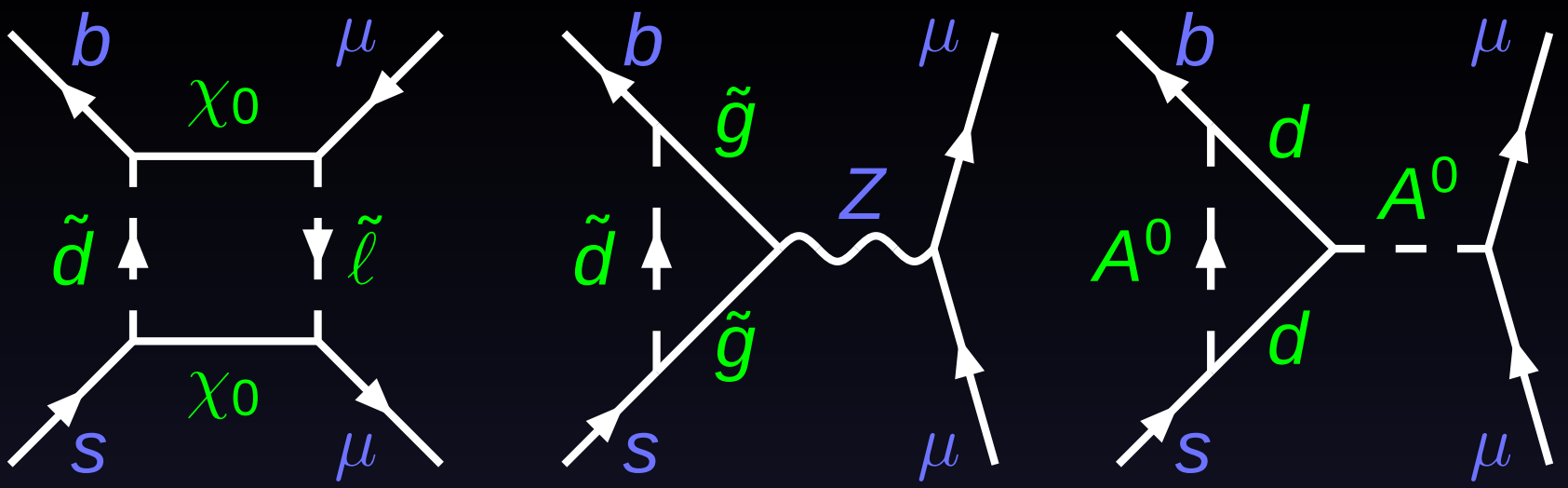
Sources:
arXiv:0712.1708
Phys. Rev. Lett. 81
5742 (1998), arXiv:0712.1516



We have box, Z-penguin, and h-penguin diagrams.

- All blobs are one-loop.
- No photon penguin due to Ward identity.



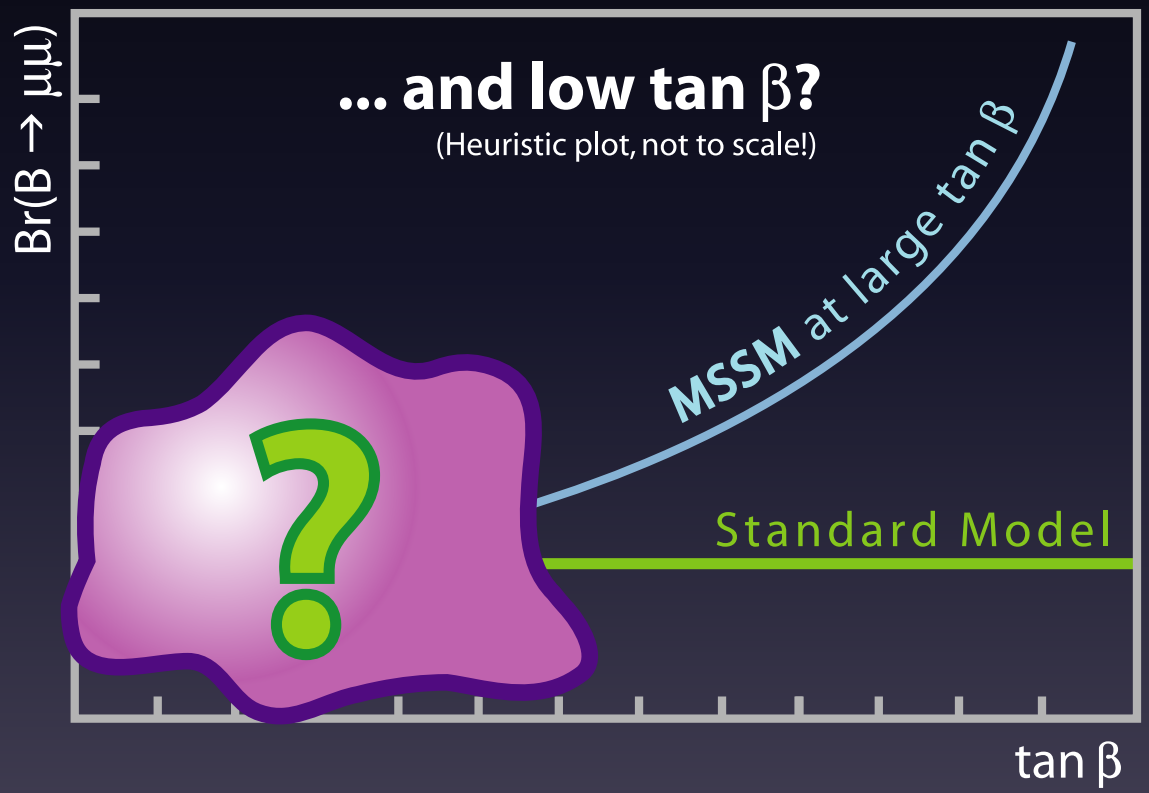


In particular, the **Super** symmetric Higgs **penguin** is enhanced by $\tan^3\beta$.

$$\text{Br} \approx 5 \times 10^{-7} \left(\frac{\tan\beta}{50}\right)^6 \left(\frac{300\text{GeV}}{M_{A_0}}\right)^4$$

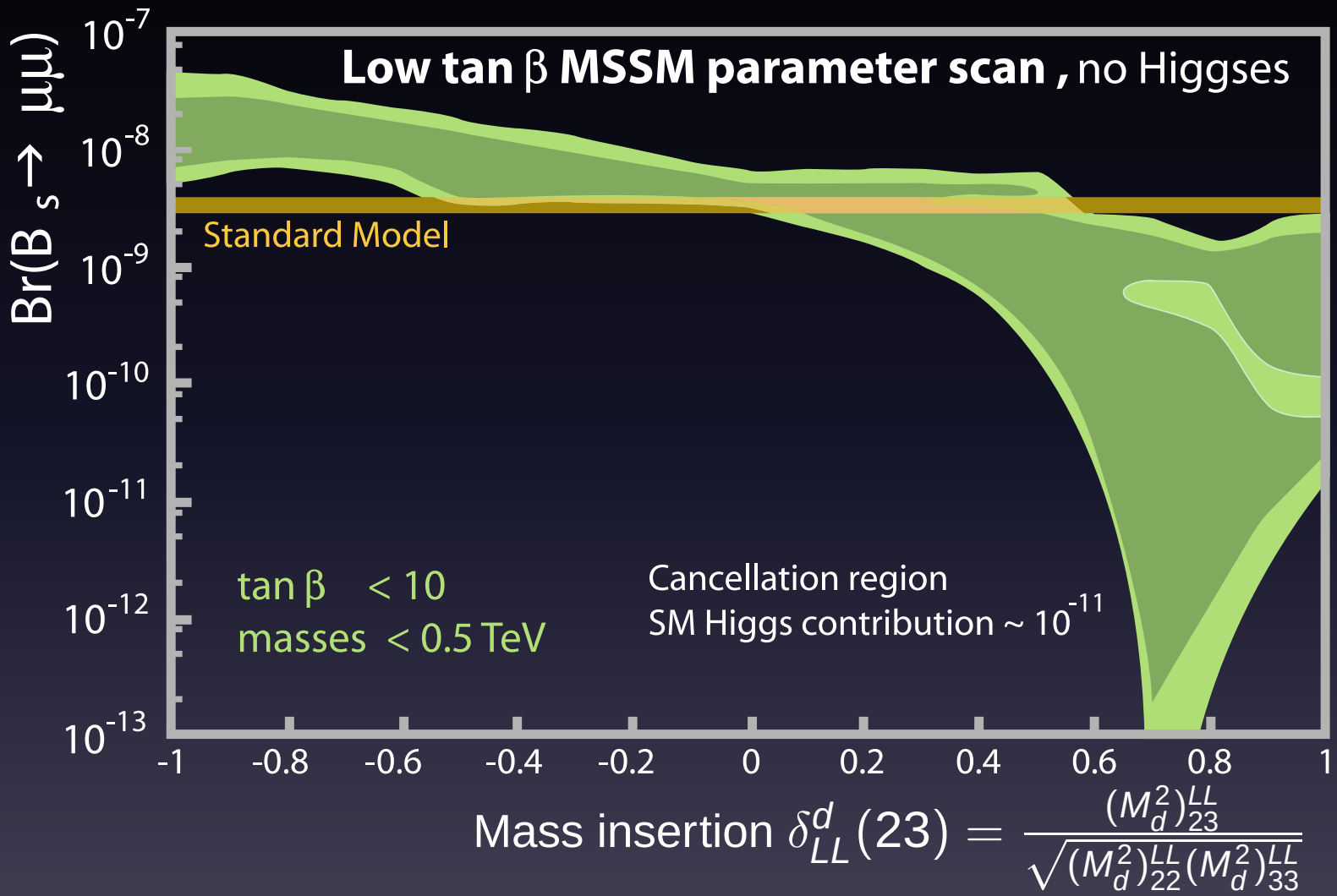
The large tan β regime has been throroughly investigated[2].
On the eve of the LHC(b), we must consider **low** tan β.

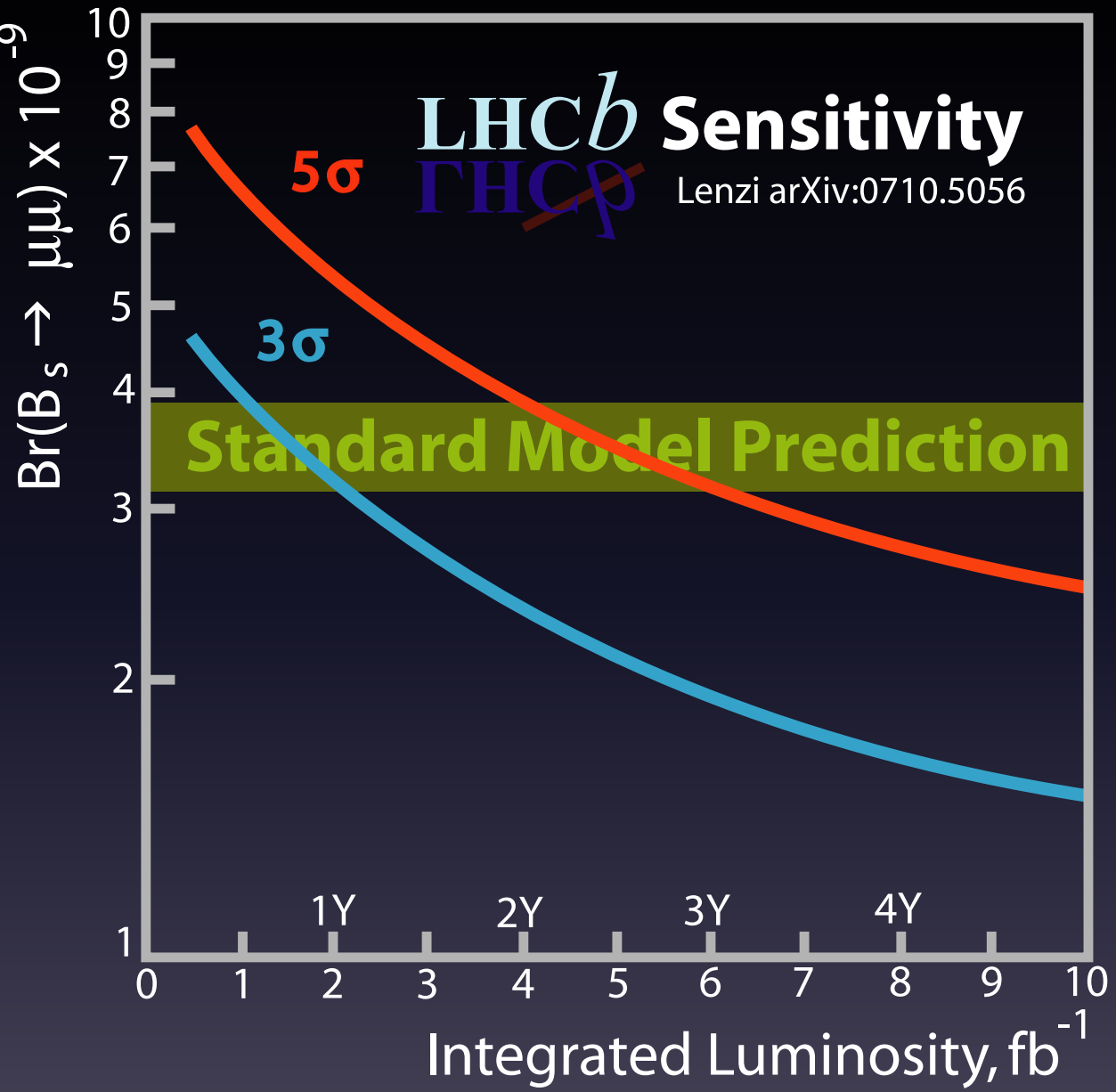
Here we expect interference when the box and Z-penguin diagrams are of the same order as the tan β-enhanced h-penguin diagrams.



[2] Buras/Buchalla '93, Chankowski/Slawianowska '01, Dedes/Pilaftsis '02, Buras/Chankowski/Rosiek/Slawianowska '03., Babu/Kolda '99, ...

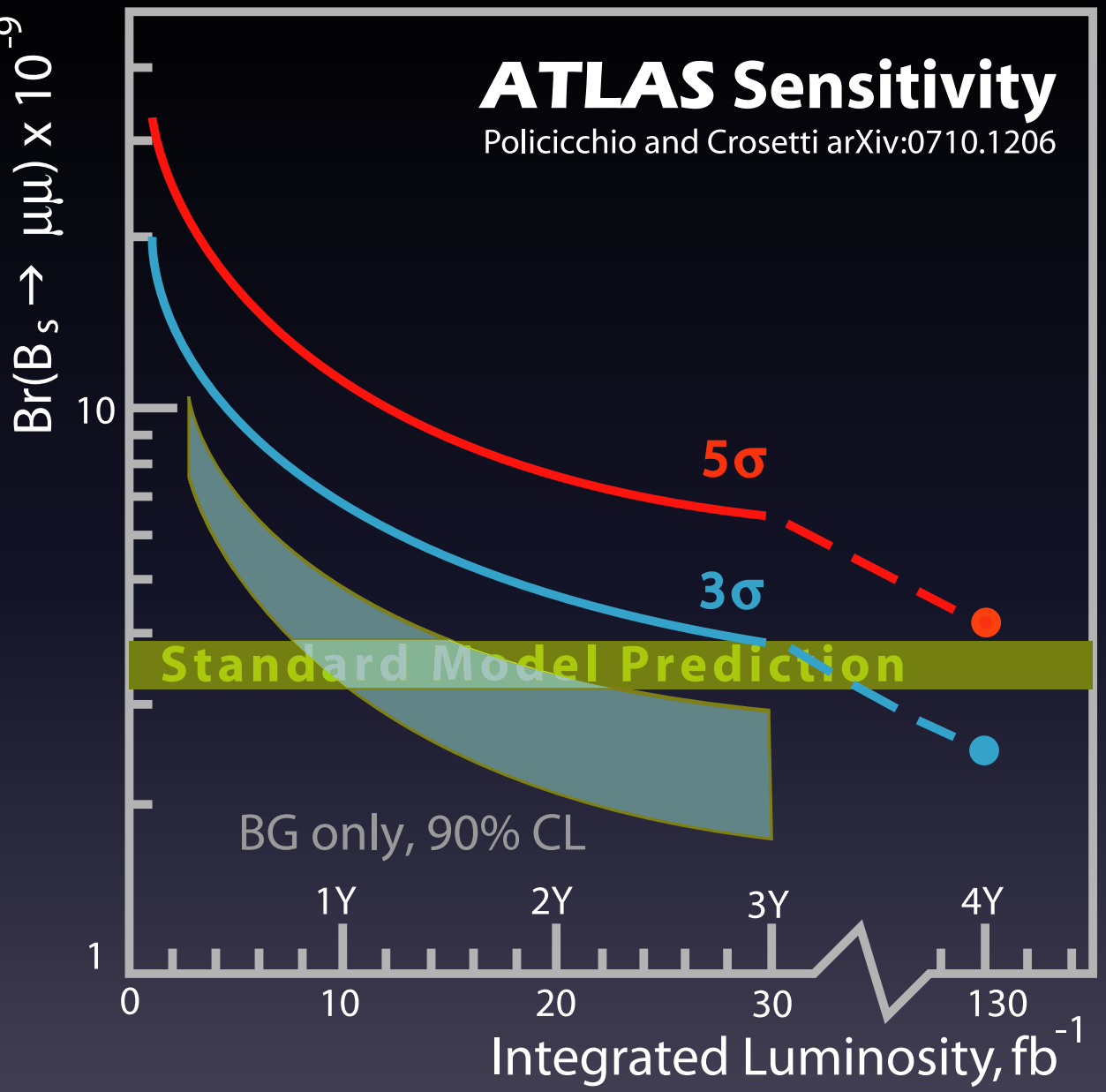
Preliminary scans





Potential...
'Signal' in 1Y
'Discovery' in 3Y

Implications on **LHCb** upgrade?
(B_s or B_d?)



GPDs will also be able to reach SM limit. (More diffi cult to tag, requires higher luminosity than LHCb.)

Conclusions

- $B_s \to \mu^+\mu^-$ might be the first signal of new physics at the LHC
- MSSM low tan β regime is experimentally promising
- Signal of new physics might be a *non-signal* of old physics
- **Next**: re-sum large *tan*β, publicly available software

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Thanks to the organisers!

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