Hbb̄ in Composite Higgs Models

Mikael Chala and José Santiago

University of Granada & CAFPE

based on arXiv:1305.1940
and JHEP **1207** (2012) 049

Outline

- Introduction to **Composite Higgs Models**

- New physics in **$b\bar{b}b\bar{b}$**

- Explicit model

- Results

- Conclusions

Outline

$$G/H, \; SU(2)_L \times U(1)_Y \subset H$$

Kaplan, Georgi, '84
Kaplan, Georgi, Dimopoulus, '84

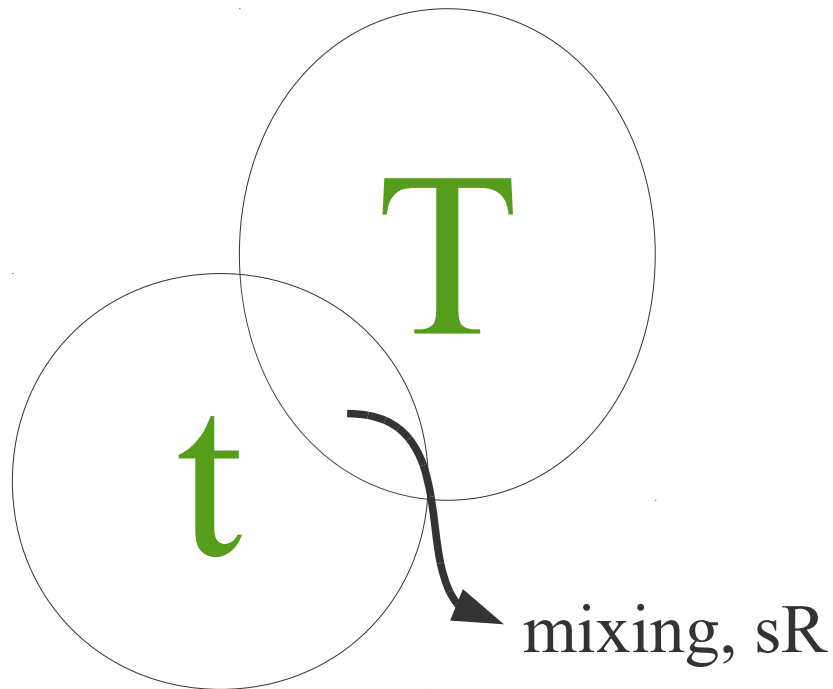**new physics!**

$$\xi = \frac{v^2}{f^2} < 1 \qquad f \simeq 1\,\text{TeV}$$

EW physics

$$v \simeq 246\,\text{GeV}$$

- The Higgs boson is a **bound state** of a **new strongly interacting sector**

- Mass also protected by its **pNGB nature**

Composite sector

T

t

mixing, sR

Elementary sector

- **Linear** couplings

- Higgs **fully composite**

- Couplings fixed by the strong sector and mixings

$$i\bar{q}\not{D}q + i\bar{Q}(\not{\partial} - m_Q) + \mathbf{\Delta_{qQ}}\bar{\mathbf{q}}\mathbf{Q} + \cdots$$
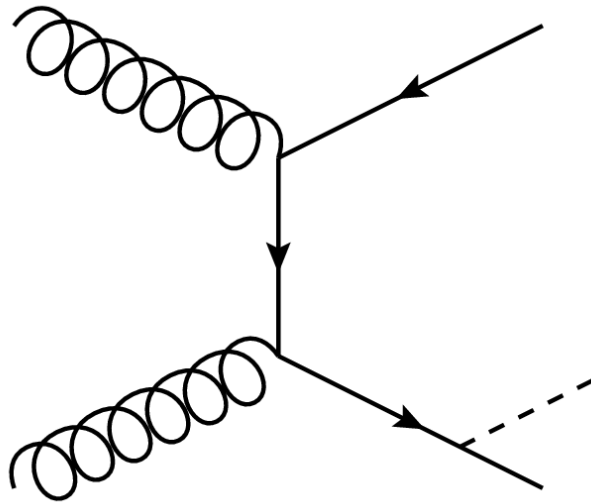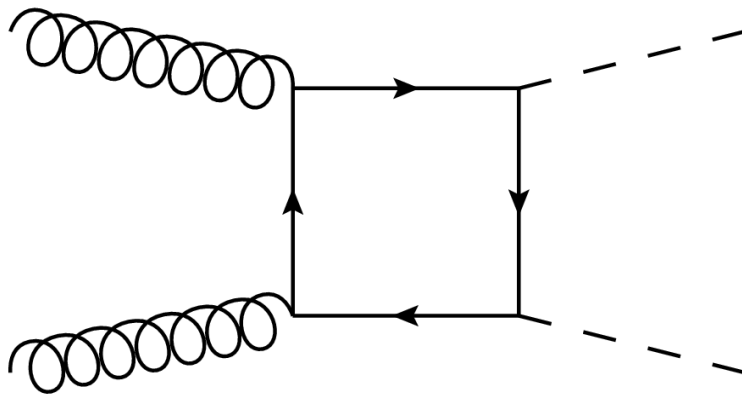
Outline

Large tan β in SUSY

Dai , Gunion, Vega, 95,
Diaz-Cruz, He, Tait, Yuan, '98,
Balazs, Diaz-Cruz, He, Tait,Yuan, '99,
Carena, Renna, Wagner, '99

CMS Collaboration,
1303.2985, '13
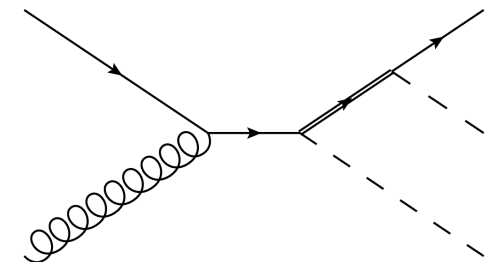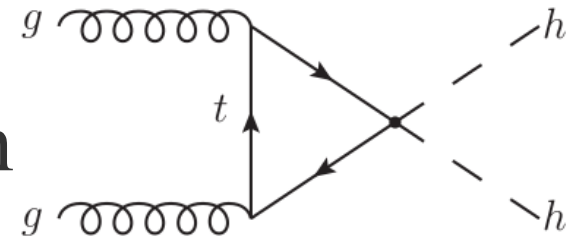
CMS Collaboration
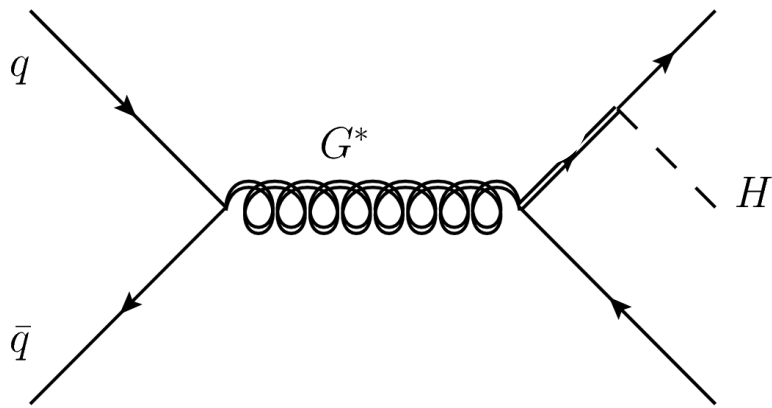PAS-SUS-12-024, '13

CMS Collaboration
1302.2892, '13

(strong) double Higgs production

Baur, Plehn, Rainwater, '04
Grober, Muhlleitner, '11
Contino, Ghezzi, Moretti et al, '12
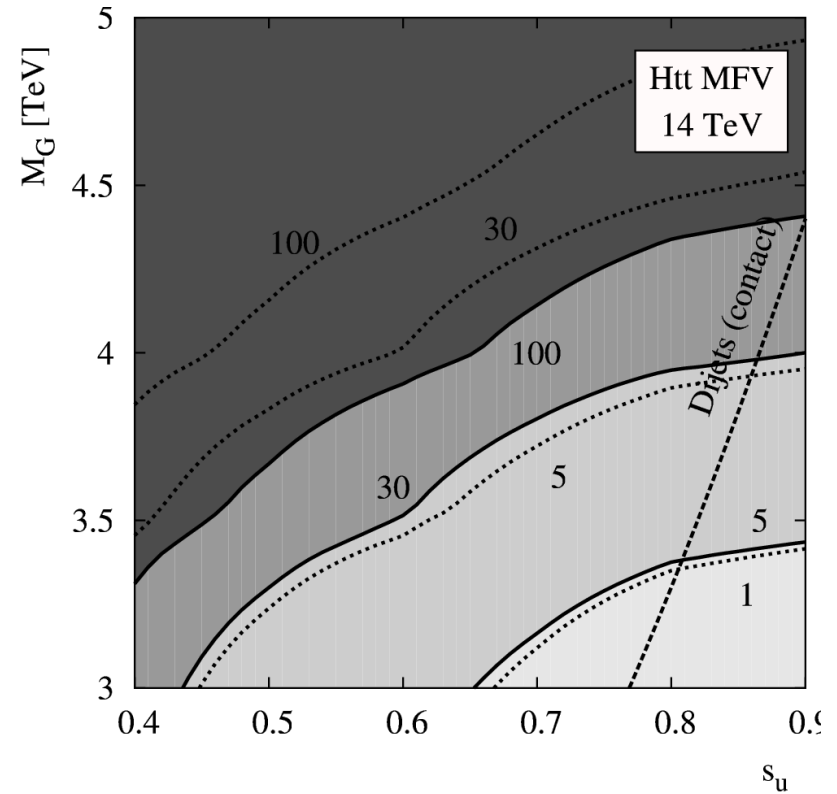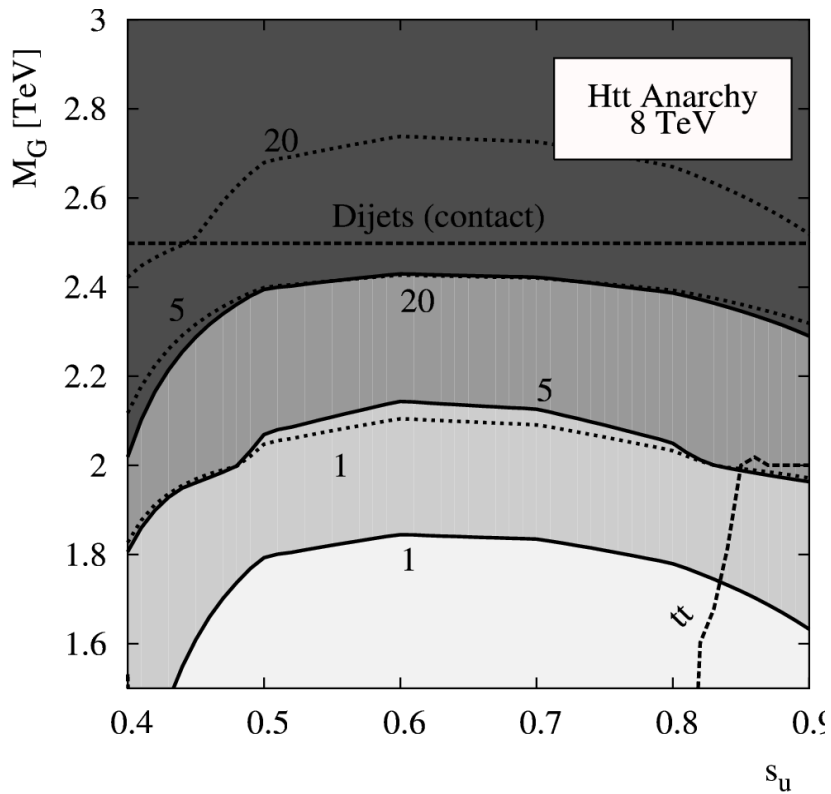**Dolan, Englert, Spannowsky, '12**

Atre, Chala, Santiago, '13

q

G^*

$\bar{q}$

H

Carmona, Chala, Santiago, '12;
Chala, Santiago, '13

Can be either $t\bar{t}H$

or $b\bar{b}H$

next slide...

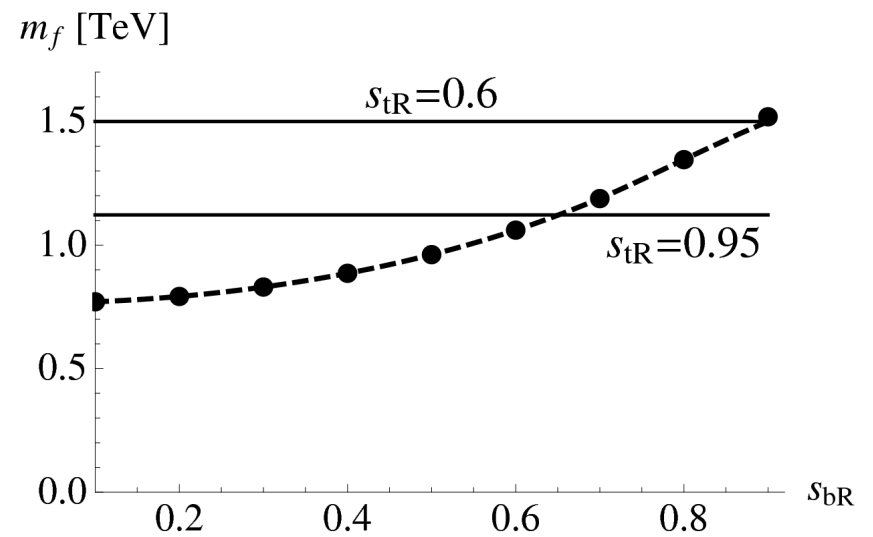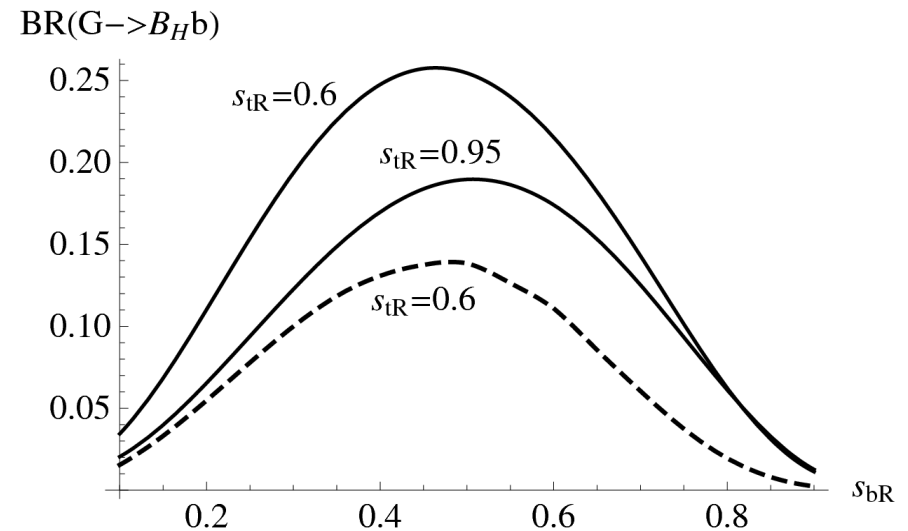# Outline

- Two-site version of the MHCM5 **Agashe, Contino, Pomarol, '05**
  Contino, Da Rold, Pomarol, '07

- Matter content in 5-dim representations of SO(5)

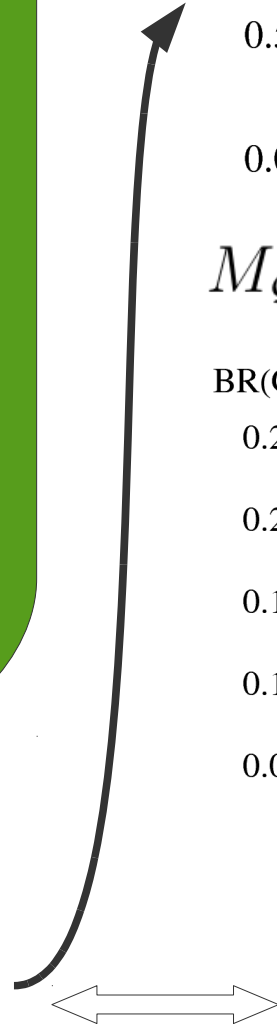- Full description of the bottom sector
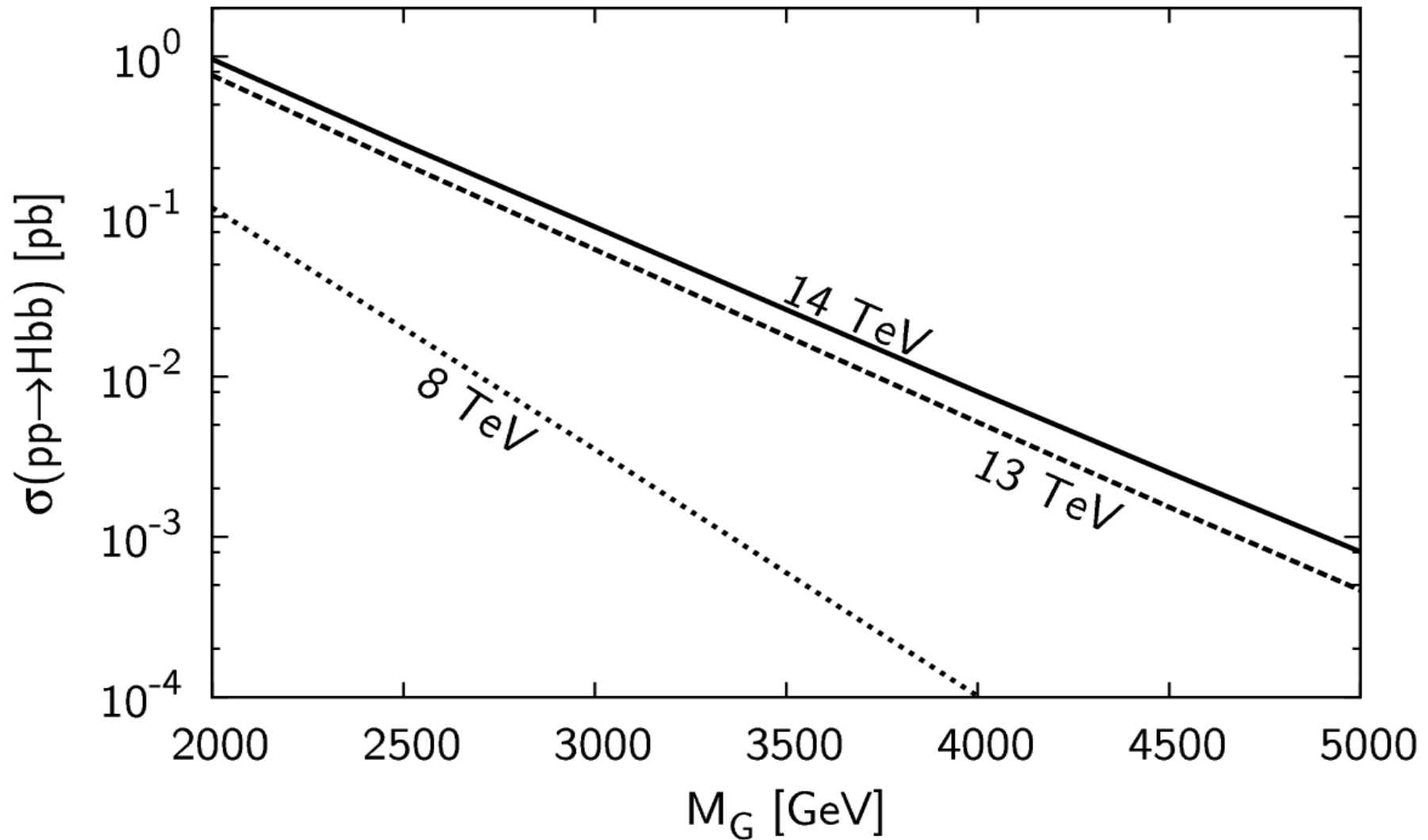
- v^2 / f^2 effects neglected

$$M_{\mathcal{Q}} = M_{\mathcal{Q}'} = M_{\tilde{T}^c} = M_{\tilde{B}^c} \equiv M_F$$

Charge **-1/3** fermion resonance typically **decays only in Hb$\bar{\text{b}}$**

$\Longleftrightarrow$

highly non-singlet behaviour
arXiv:1305.1940 (Appendix A)

Mikael Chala

Large cross sections...
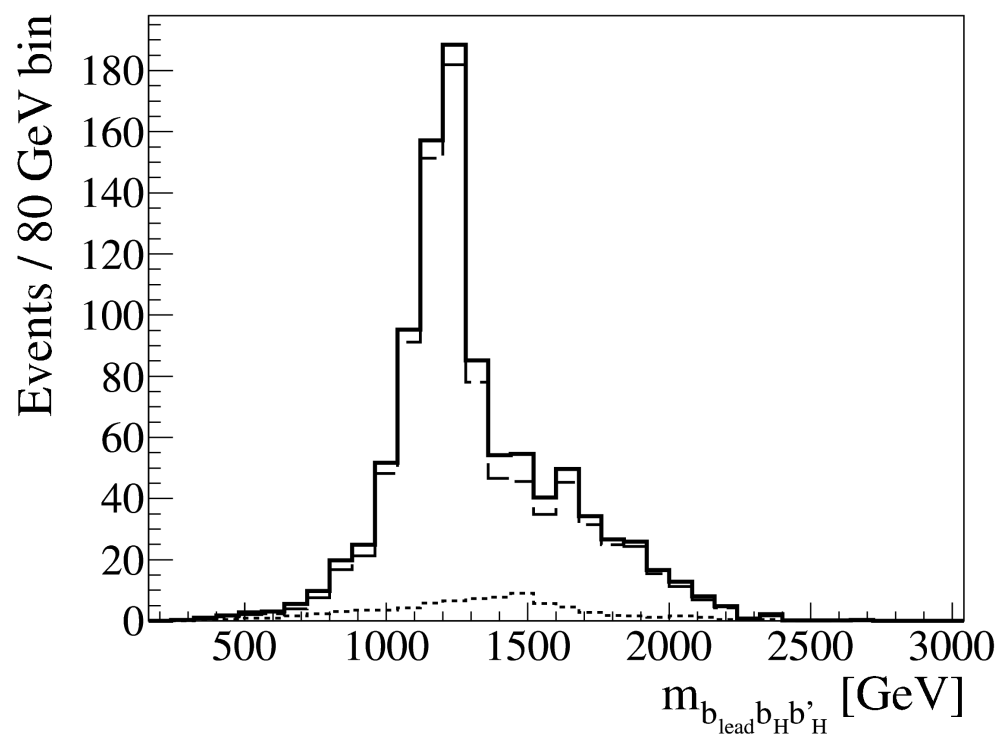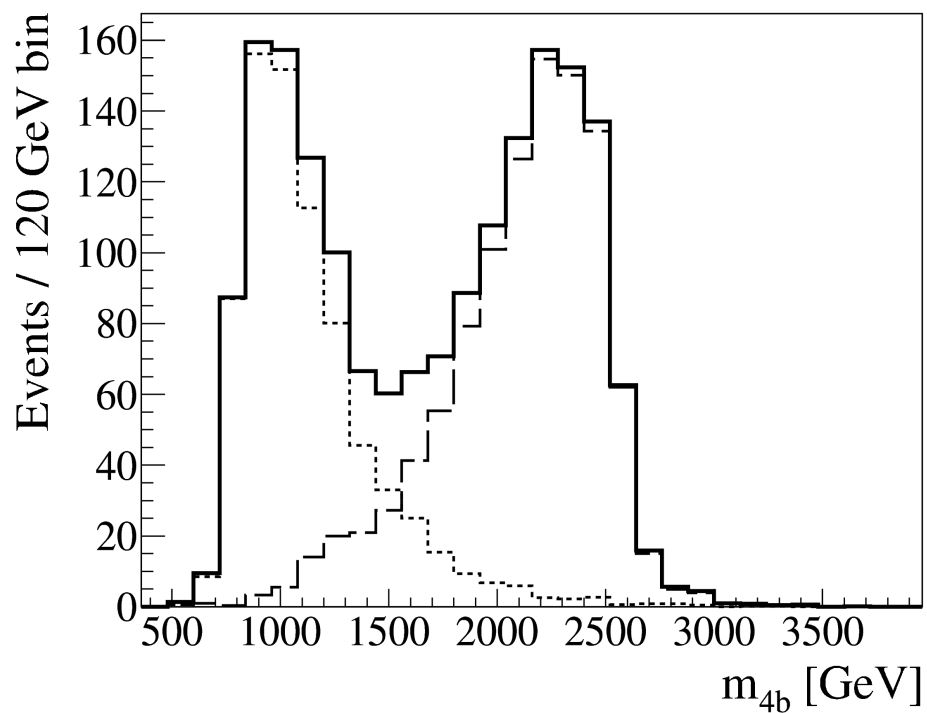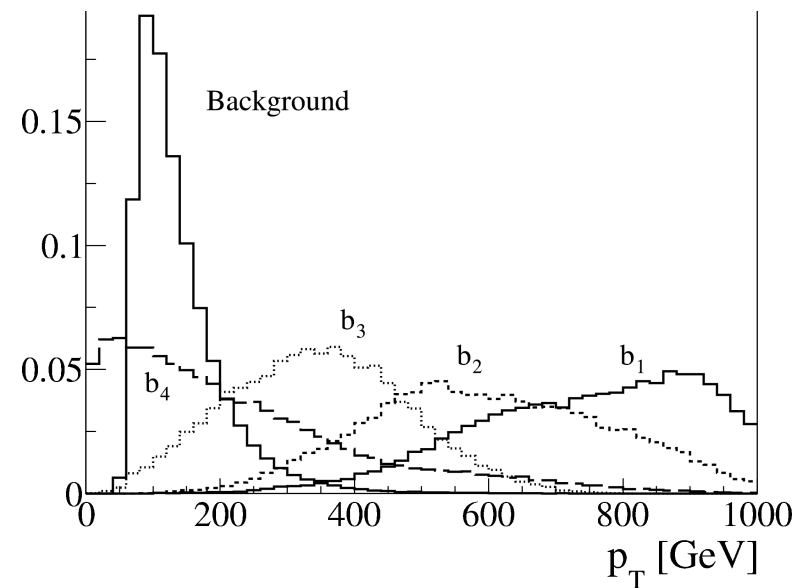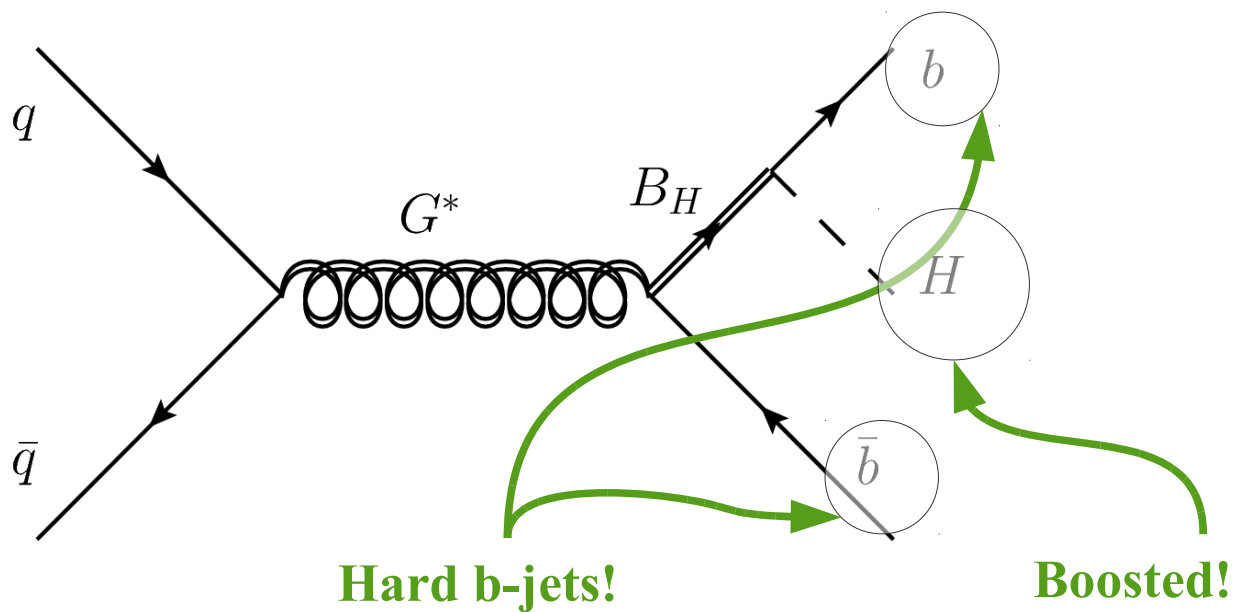
Hard b-jets!   Boosted!

Outline

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- 🙂 New physics in **b b̄ b b̄**

- 🙂 Explicit model

- 🙂 Results

- 🙂 Conclusions

Results for 8 TeV...

Results for 14 TeV...

Domenech, Pomarol, Serra, '12;
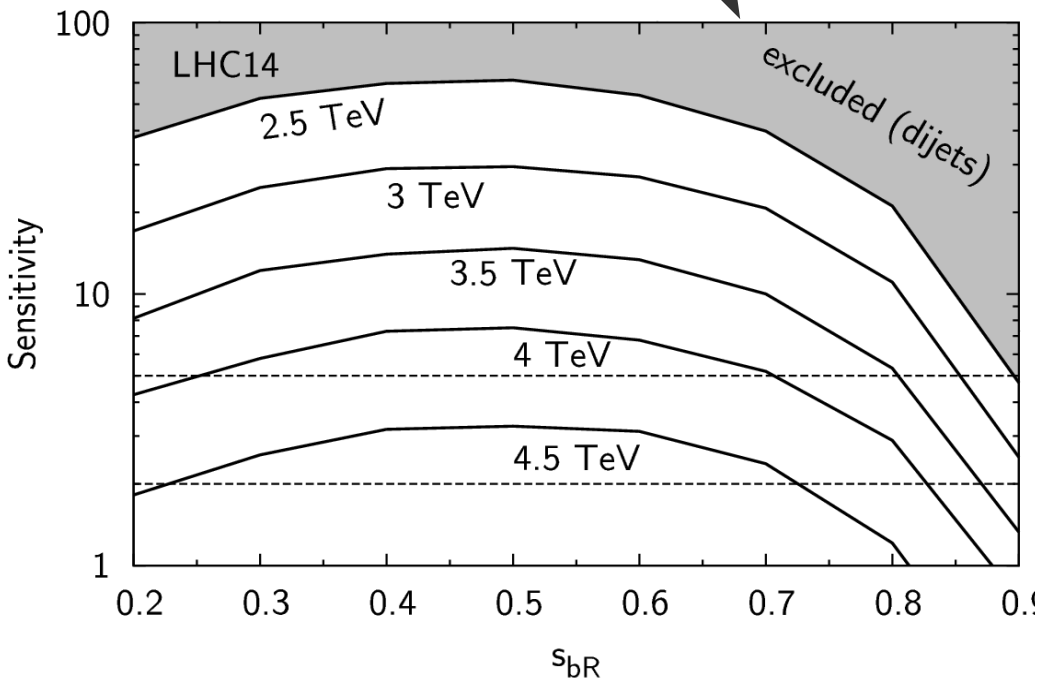
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Conclusions

◆ **New physics** scenarios are highly populated of **four bs final states**
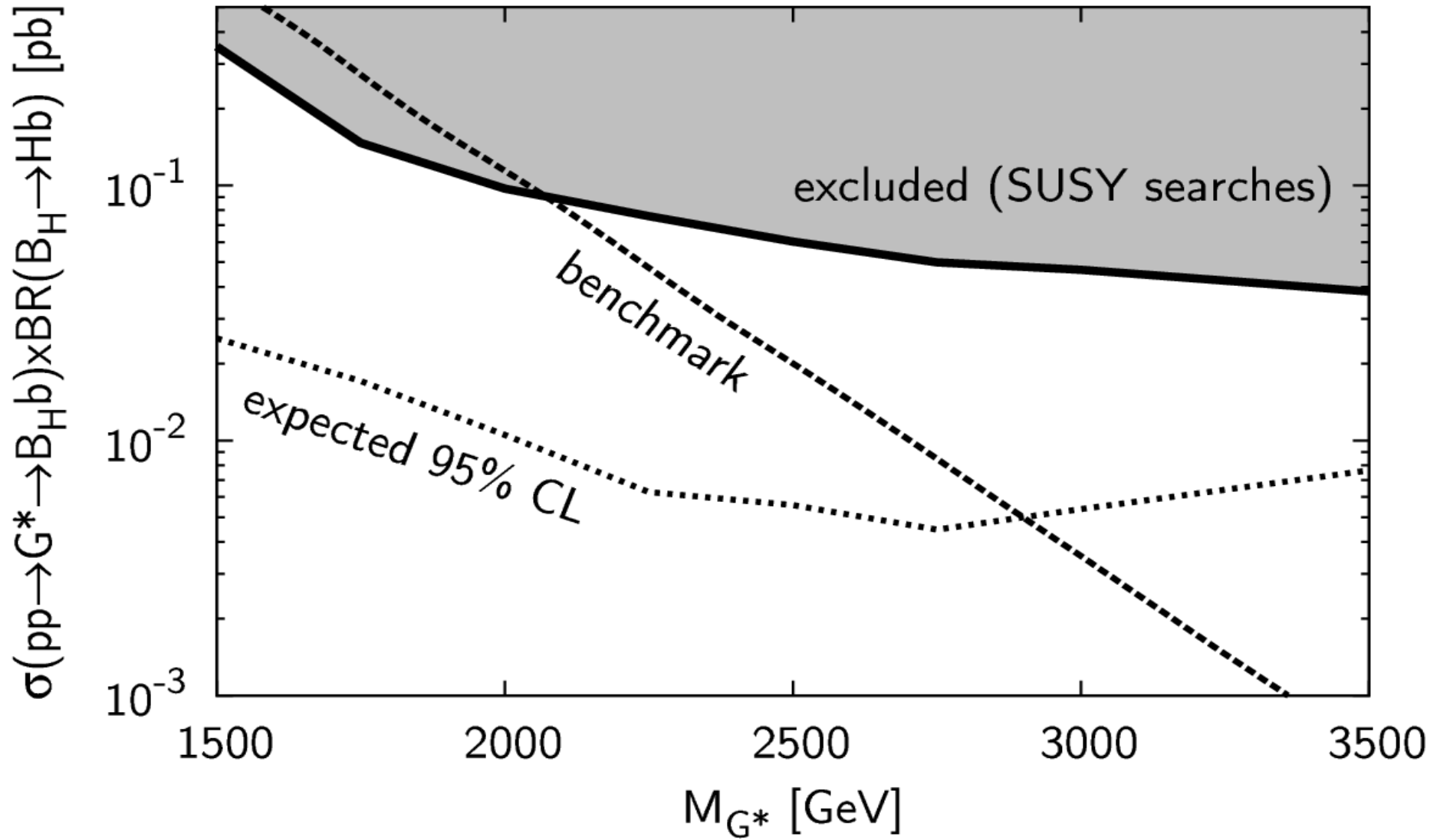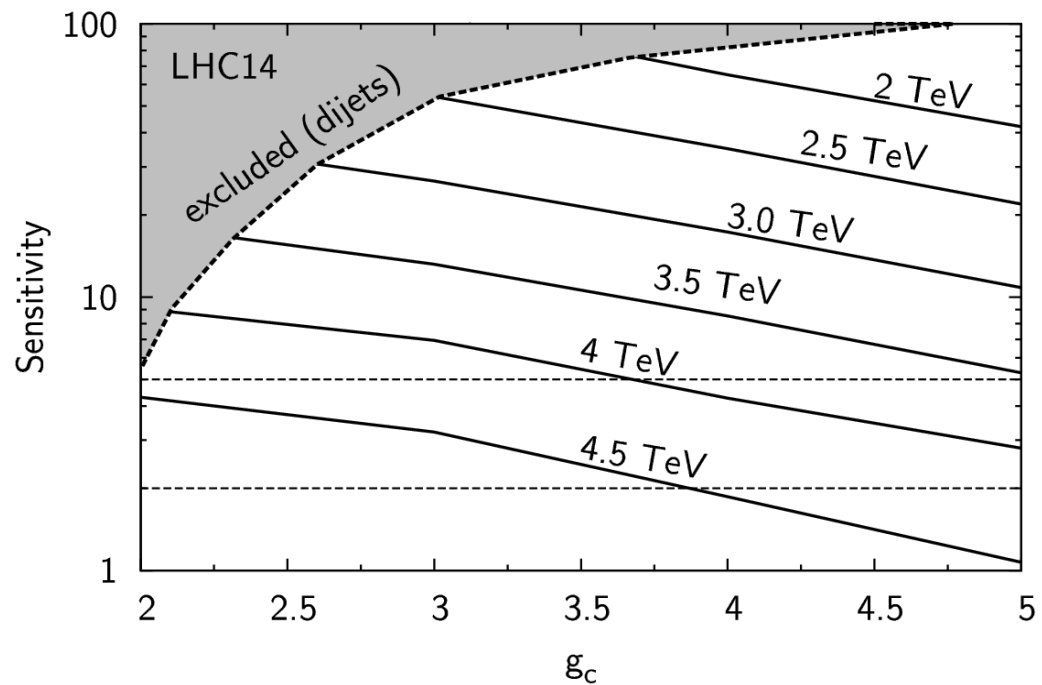
◆ **CHMs** with partial compositeness provide 4b channels with very **distinctive kinematics**

◆ **Current searches** are already sensitive, but still **far from dedicated analyses**

◆ Heavy gluon masses of **up to 3 (5) TeV can be tested** at the LHC

◆ Time to look into new phase space regions!

Thank you for your attention!

Backup!

Cuts...

$$N_b \geq 4, \quad N_l = 0, \quad p_T(b) \geq \begin{cases} 50 \text{ GeV (LHC8)}, \\ 60 \text{ GeV (LHC14)}, \end{cases}$$

$$p_T(b_1) \geq \begin{cases} 200 \text{ GeV (LHC8)}, \\ 300 \text{ GeV (LHC14)}, \end{cases} \quad p_T(b_2) \geq \begin{cases} 100 \text{ GeV (LHC8)}, \\ 200 \text{ GeV (LHC14)}, \end{cases}$$

$$|m_{b_H b'_H} - m_H| \leq 30 \text{ GeV},$$

8 TeV	N_b	N_l	p_T^b	$p_T^{b_1}$	$p_T^{b_2}$	$|m_{bb} - m_H|$	$m(4b)$
Signal	16	99	68	99	99	56	89
Background	17	99	10	13	89	46	0.7
14 TeV							
Signal	16	99	59	98	98	59	92
Background	20	99	12	7.6	63	36	11

Boosted regime...

More than **30% (60%)** for a mass of **2.5 TeV (4 TeV)**

14 TeV		
Signal	16	99
Background	20	99