New vectorlike production mechanisms at the LHC

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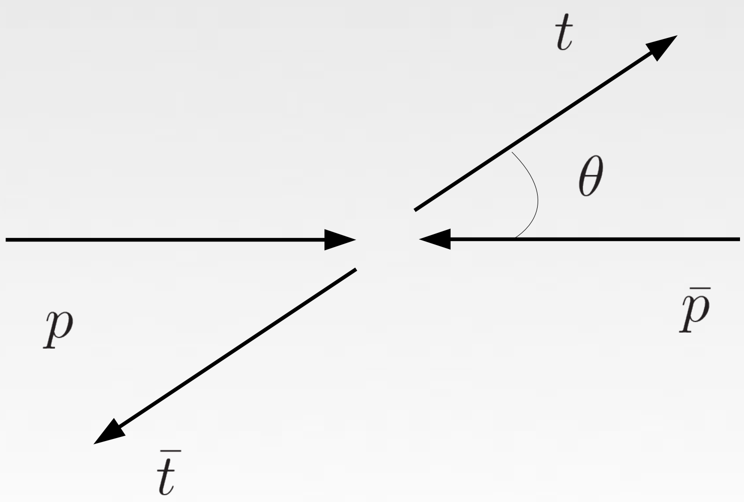
based on R. Barceló, A. Carmona, M. Chala, M. Masip, J. Santiago
[arXiv:1110.5914]

The Tevatron FB asymmetry



$$A^t_{FB} = \frac{N_t(p) - N_t(\bar{p})}{N_t(p) + N_t(\bar{p})}$$

A heavy gluon excitation?

CDF Collaboration

$$A^t_{FB} = 0.474 \pm 0.114$$

$$(m_{t\bar{t}} > 450 \text{ GeV})$$

A NLO QCD effect in SM

A 3 sigmas deviation from SM prediction!

Consistency among different CDF and D0 measurements

No new physics in other observables (invariant mass, cross section, dijets production)

Stealth gluon

Assume a new massive gluon G:

Large effects require relatively low masses

$$a)\ m_G \lesssim 1\ \text{TeV}$$

$$b)\ g_L^q \simeq -g_R^q,\ \text{large}\ g_R^t$$

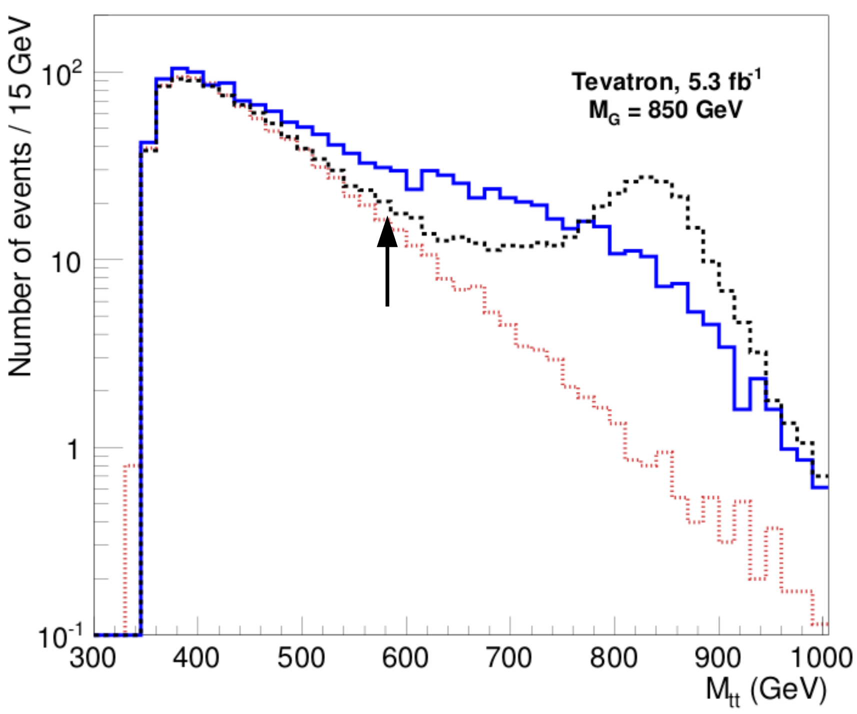
Small-close to axial couplings!

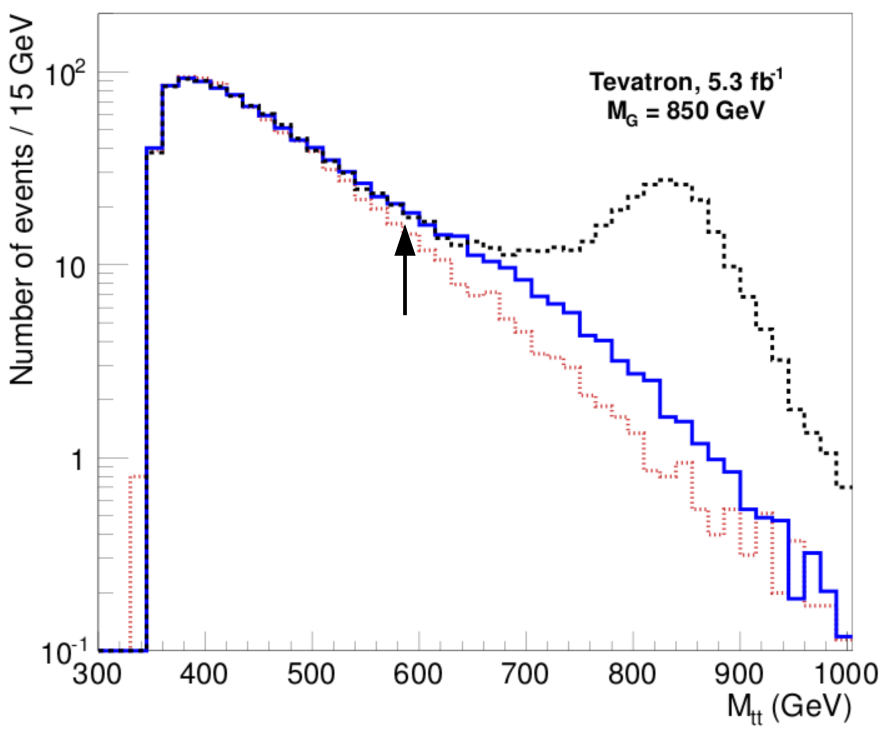
Vanishing interference with the SM

Stealth gluon

A larger coupling of the top quark to G increases the FB asymmetry and dilutes de peak (left figure)

Adding a new decay channel that increases its width further reduces the top-quark production (right figure)





Stealth gluon

Assume a new massive gluon G:

$$a)\, m_G \lesssim 1\ \text{TeV}$$

$$b)\, g_L^q \simeq -g_R^q,\ \ \text{large}\, g_R^t$$

$$c)\, \Gamma_G = (0.5 - 0.7) m_G$$

Proper treatment of energy-dependent effects!

Provided by new decay modes

$$G \to Q\bar{q},\ q\bar{Q}$$

A benchmark model

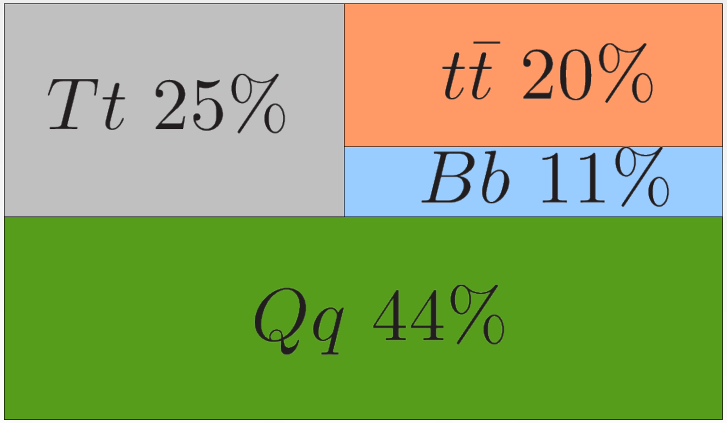
Masses:

$$a)\ m_G = 850\,\mathrm{GeV}$$

$$b)\ m_T = 450\,\mathrm{GeV}$$

$$c)\ m_B = m_Q = 600\,\mathrm{GeV}$$

All the decay channels are included!



$$\Gamma_G \sim 0.7 m_G$$

Couplings:

$$a)\ g_L^q = 0.3 g_s,\ \ g_R^q = g_R^b = -0.3 g_s,\ \ g_R^t = 4 g_s$$

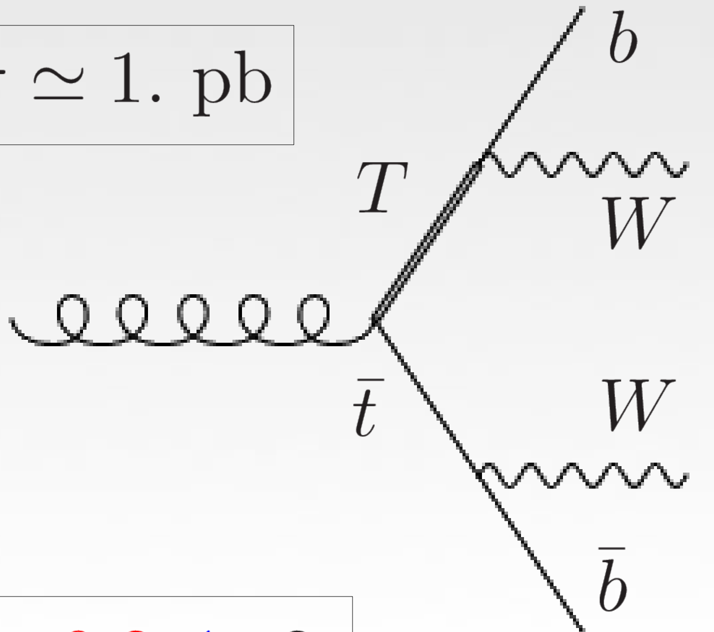
$$b) g_R^{Tt} = 4 g_s,\ \ g_R^{Bb} = 3.5 g_s, g_L^{Qq} = 3.5 g_s$$

We also consider models in which

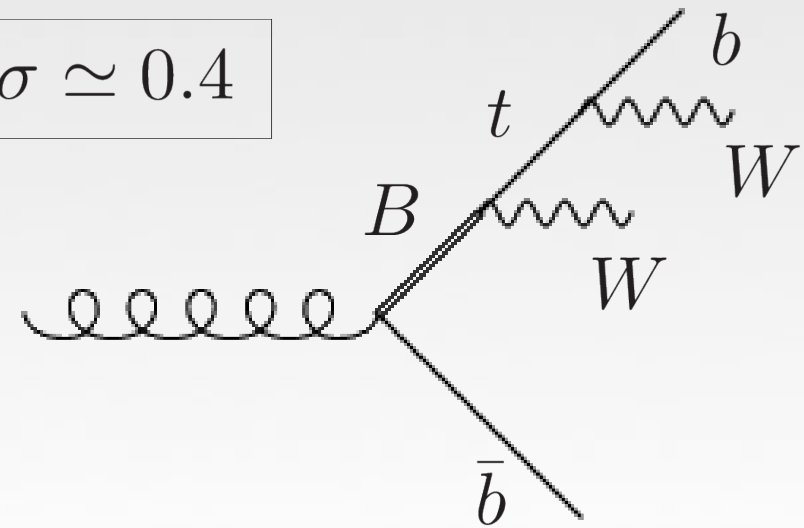
$$BR(\Psi\psi) \simeq 80\%$$

Feynman diagrams

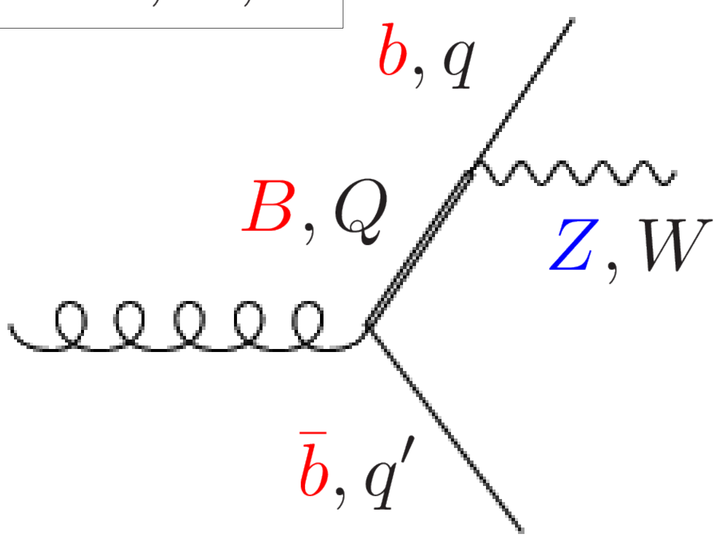
$\sigma \simeq 1.$ pb



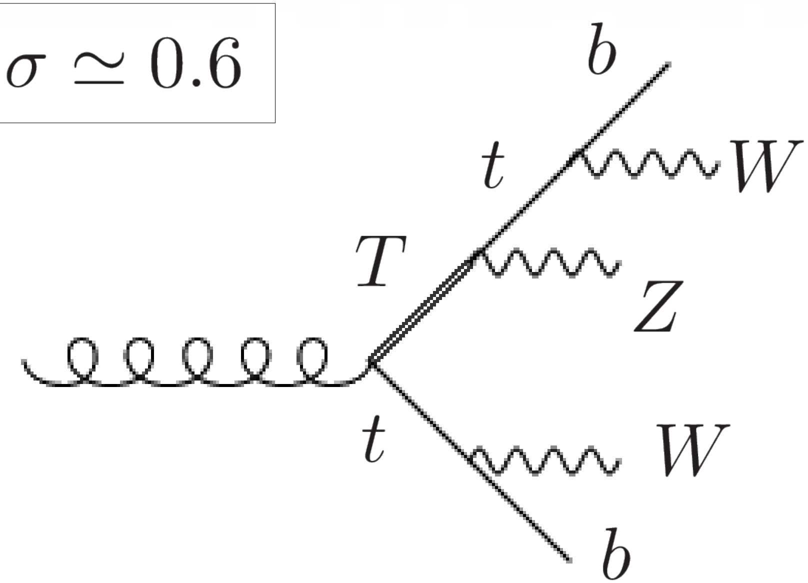
$\sigma \simeq 0.4$



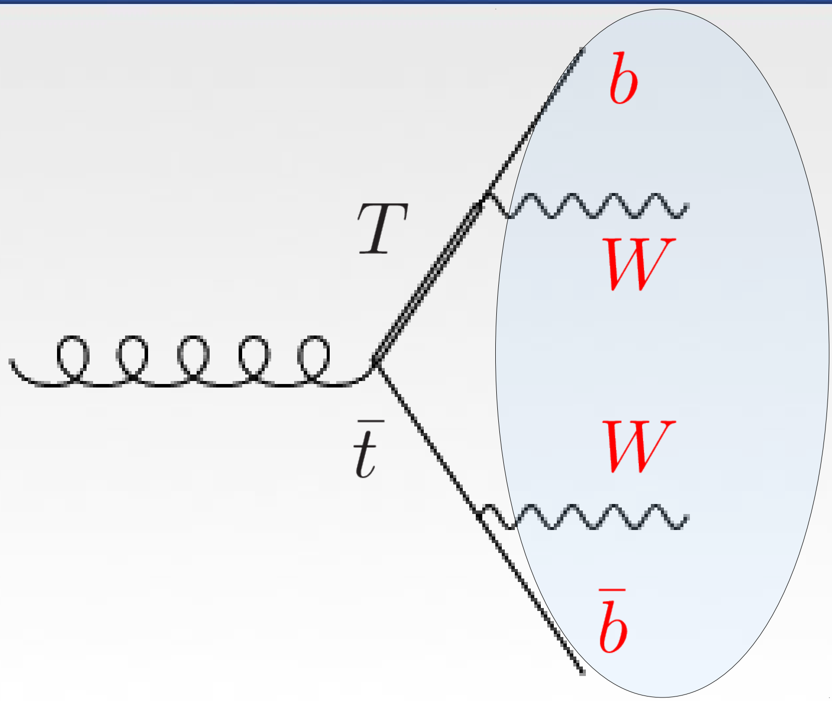
$\sigma \simeq 0.2, 1., 2.$

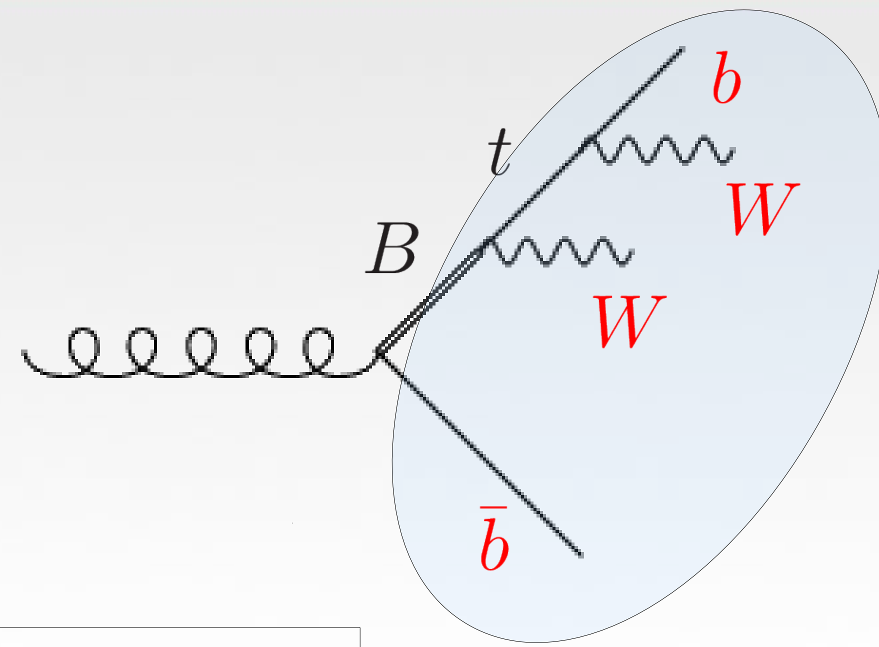


$\sigma \simeq 0.6$

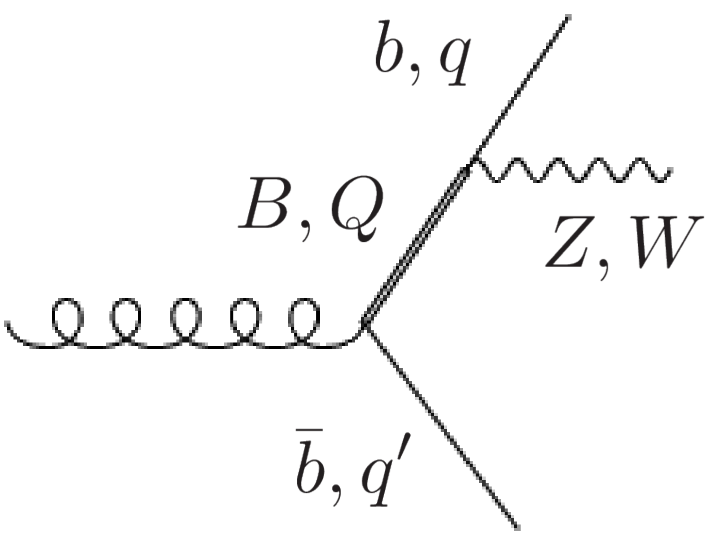


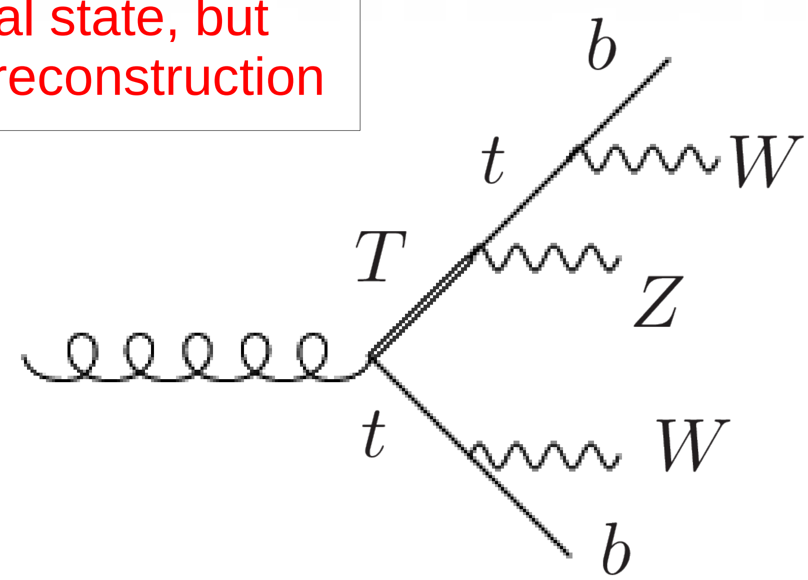
Feynman diagrams





Same final state, but different reconstruction



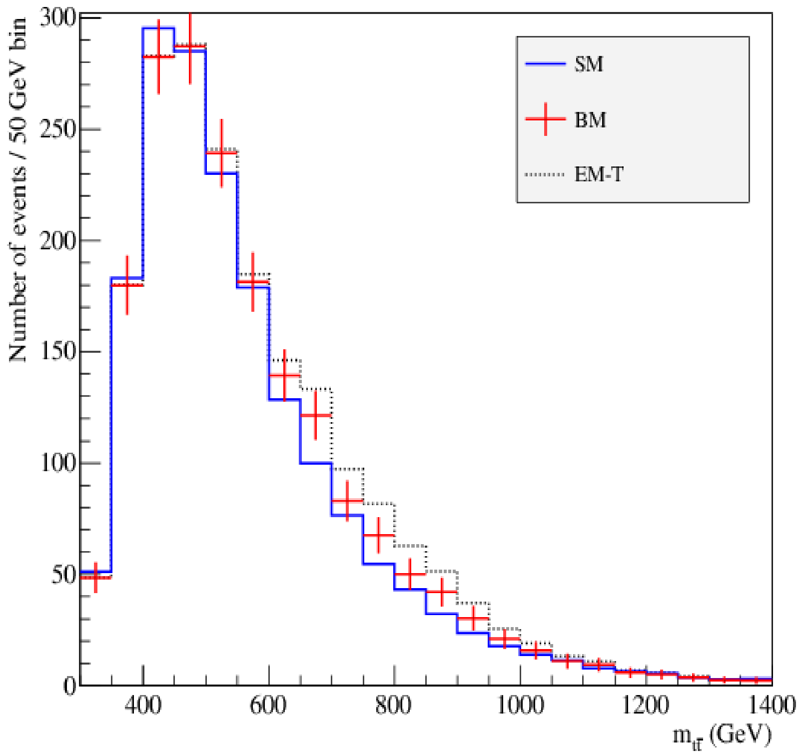


$t\bar{t}$ and $T\bar{T}$ searches

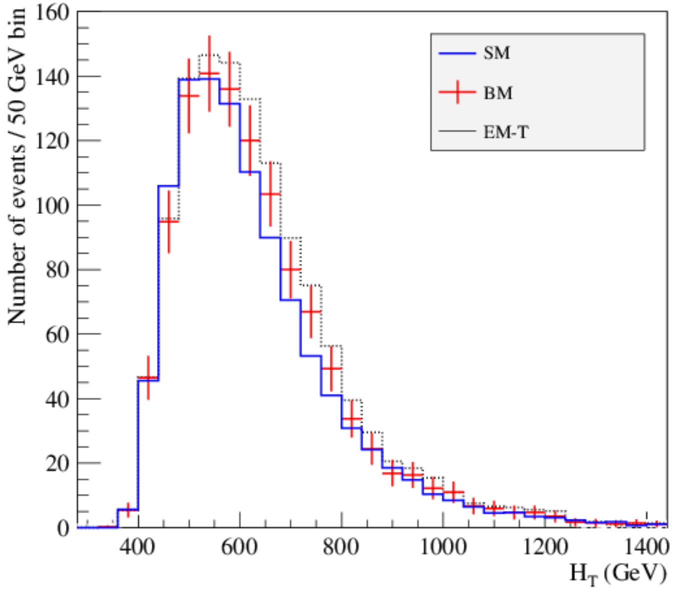
$$q\bar{q} \to G \to t\bar{t}, t\bar{T}(\bar{t}T), b\bar{B}(\bar{b}B)$$

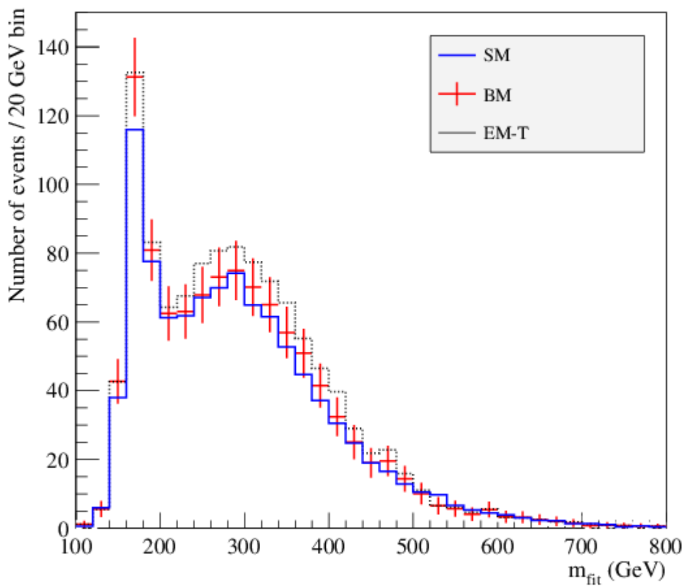
contribute to ttbar-like searches

Current LHC searches are not yet sensitive, but could soon probe extreme cases



HT and mfit distributions (TT)





$T\bar{t}$ dedicated analysis

Strategy:

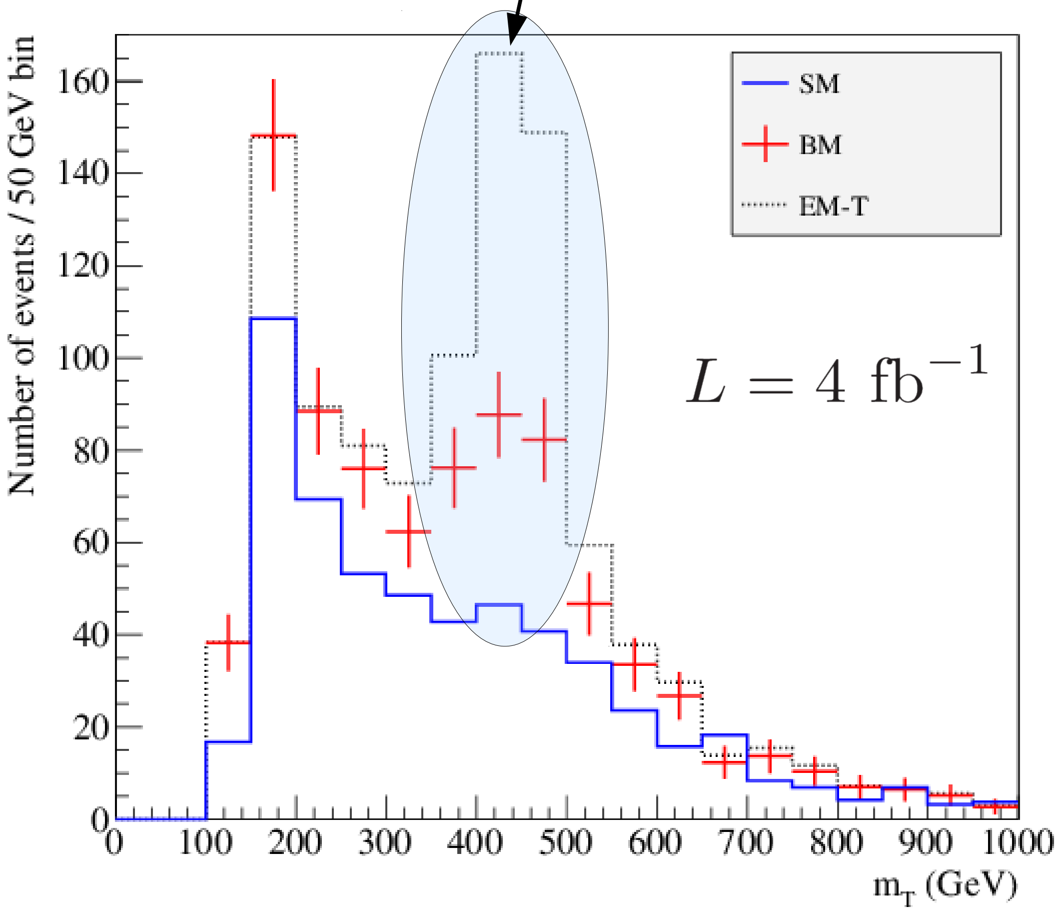
Search for one top and reconstruct the other leg (without imposing mt constraint)

Go to total invariant masses above 600 GeV

$$p_{T_{j_h}} > 200 \text{ GeV}$$

Similar analyses for Bb are also possible, but less conclusive

Very clear excess in both benchmark and extreme models!



$Zb\bar{b}$ channel

Simple cuts:

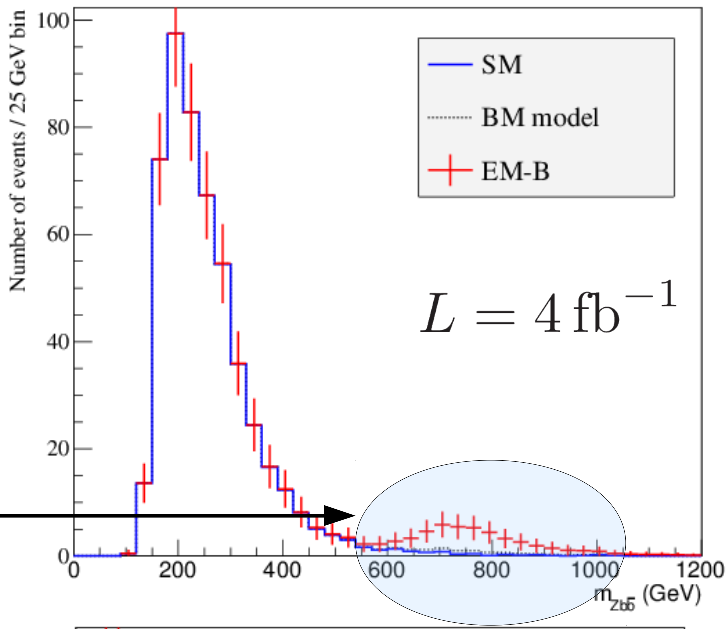
a) exactly 2 leptons, PT > 25 GeV

b) 25 GeV within the Z mass

c) two b-tagged jets, PT > 20 GeV

d) missing ET < 40 GeV

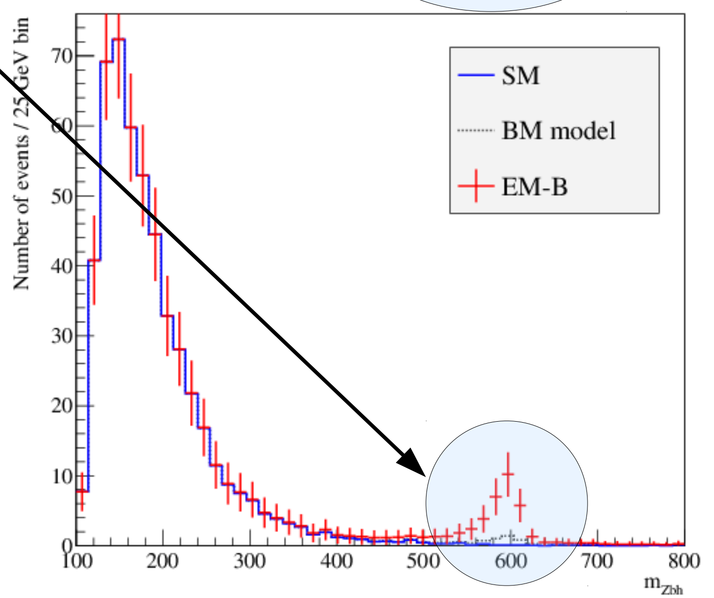
Disentanglement of both Q and G!



Main backgrounds:

a) Zbb (irreducible)

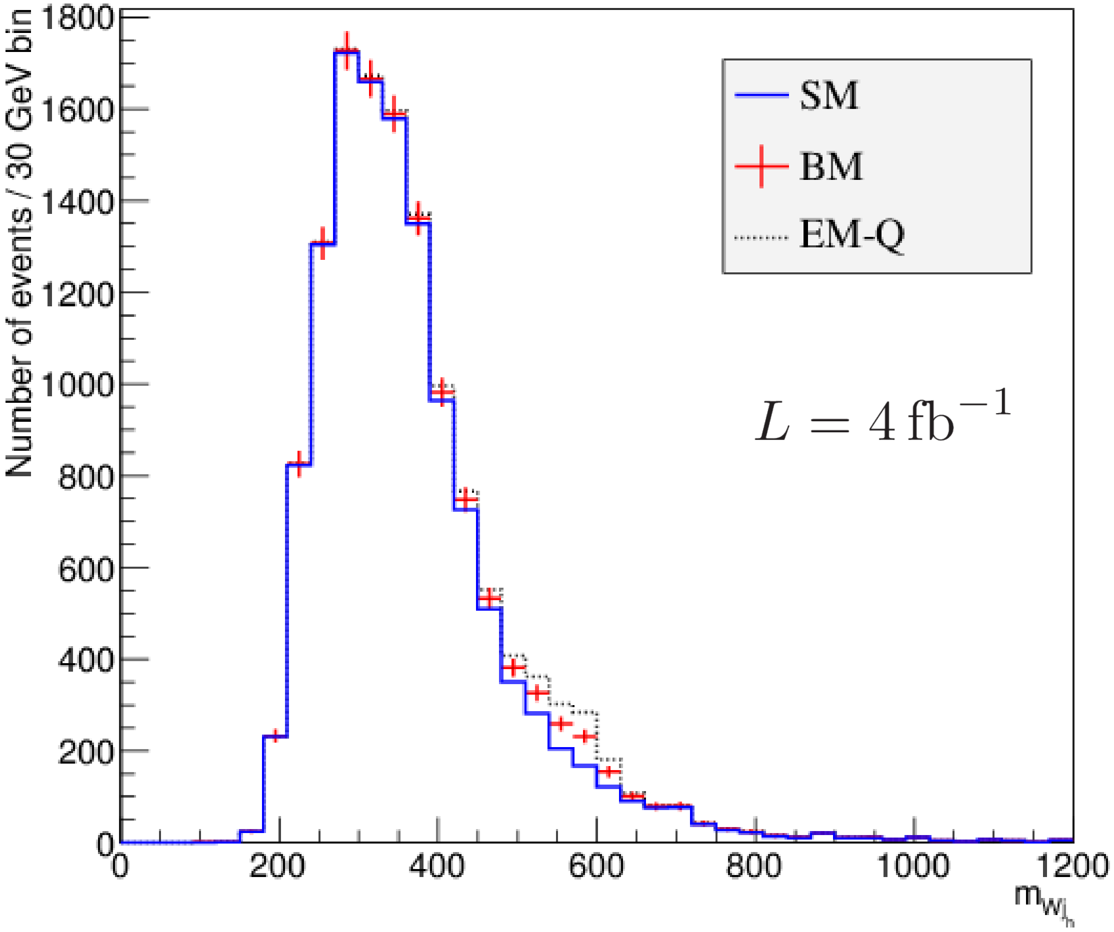
b) Z + jets, ttbar



Signal and background peak at very different regions

Wqq' channel

Transverse mass distribution
of the W and the hardest jet:



How to deal with the **very large background**:

a) Exactly 1 lepton, PT > 20 GeV

b) Missing ET > 25 GeV

c) mT > 40 GeV

d) >= 2 jets, PT > 30 GeV

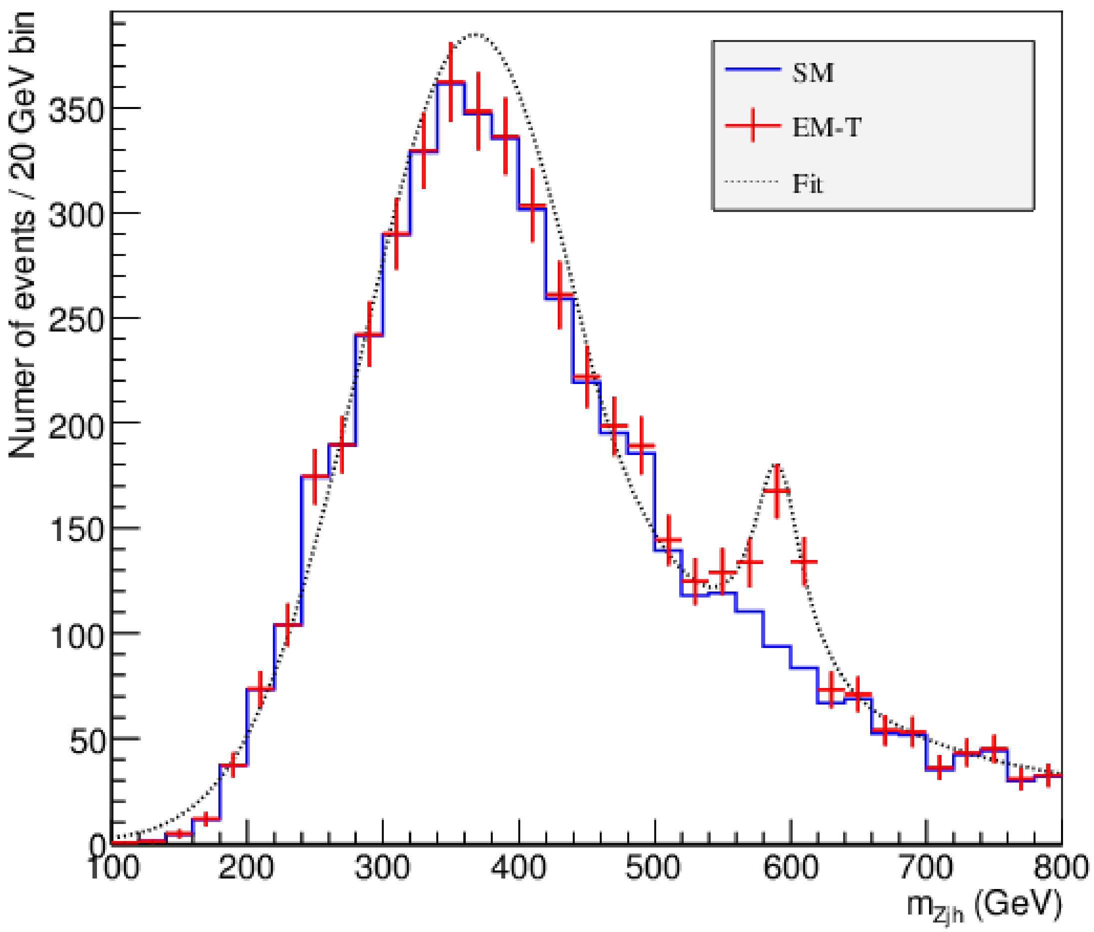
e) PT(jj) > 40 GeV

f) PT > 150 GeV

No significant excess in the BM but may be observable in the EM-Q.

Zqq' channel

Invariant mass distribution of the Z and the hardest jet:



Again: PT > 150 GeV

We can **perform a fit** to extract the clear excess over the background:

mfit = 590 GeV

$$\frac{S}{\sqrt{B}} \simeq 7\,!$$

Conclusions

The Tevatron FB asymmetry is a strong motivation for a search of correlated effects from new physics

It can be explained by a heavy gluon with new decay channels $G \to Qq$

We have studied the consequences of these processes in current analyses and possible signals to be searched

ATLAS and CMS are studiying in detail tt and TT production. We have shown that Tt and Bb could be also studied there

Zqq and Zbb look very promising.

Thank you for your attention!