Top partners in Same-Sign Dileptons : A Strong Sector at the LHC

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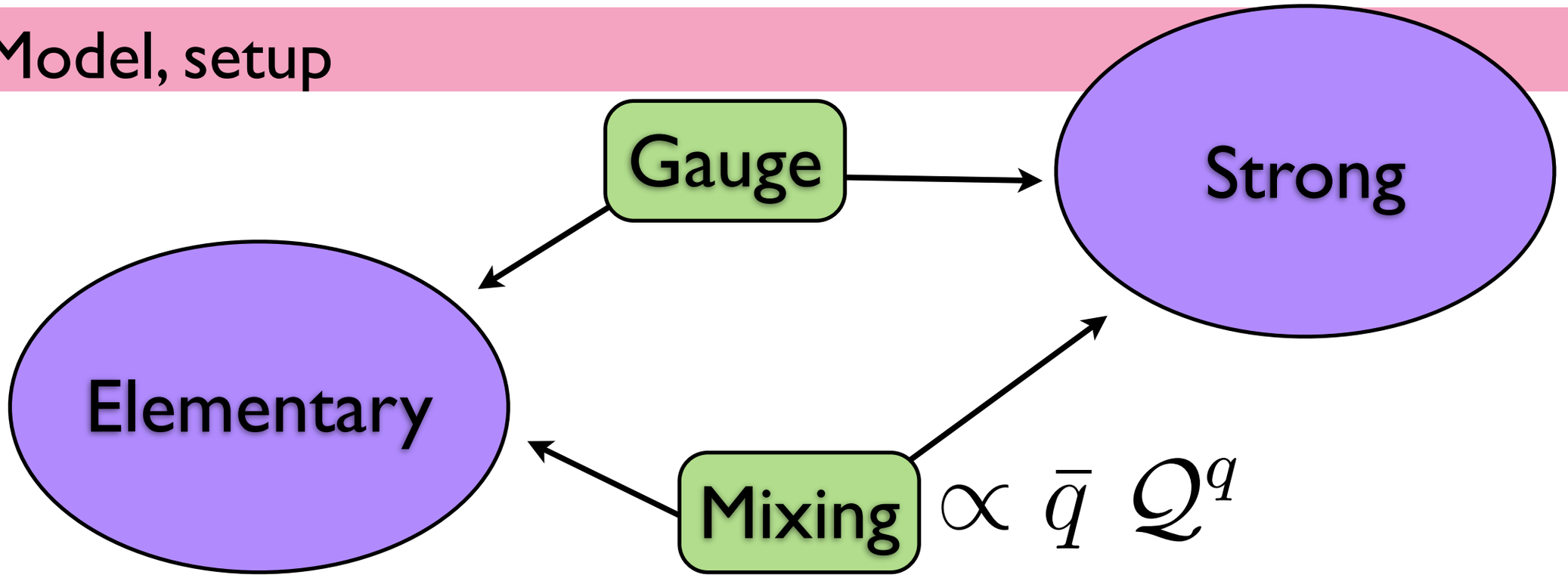
Based on PRD 81:075006, with A. Wulzer

Model, setup



- New coloured fermions : $Q, \tilde{T}, \tilde{B}$
- $\mathrm{IR} : i\bar{q}\not{\partial}q + i\bar{Q}\not{\partial}Q - m\bar{Q}Q + M\bar{q}\lambda_q Q + \mathrm{h.c.}$
- $y_q \sim \dfrac{\lambda_L \lambda_R}{g_\rho} \Rightarrow$ light ↔ elementary; heavy (top) ↔ composite

Model, Fermions

- **Strong sector :** $G \supset H \supset SO(4) \sim SU(2)_L \times SU(2)_R$

- **Experimental hint on the structure :**

$$\supset T_{5/3},\ B$$

$$Q = (2,2)_{2/3}\ ;\ \tilde{T} = (1,1)_{2/3} \quad \begin{cases} \delta\rho \propto \lambda_L^2 \\ \dfrac{\delta g_{Zbb}}{g_{Zbb}} \propto \lambda_L^2 \end{cases}$$

$$\Rightarrow\ \lambda_R \text{ maximal, } \lambda_L \text{ minimal}$$

$$2 \lesssim \lambda_{T,B} \lesssim 4$$

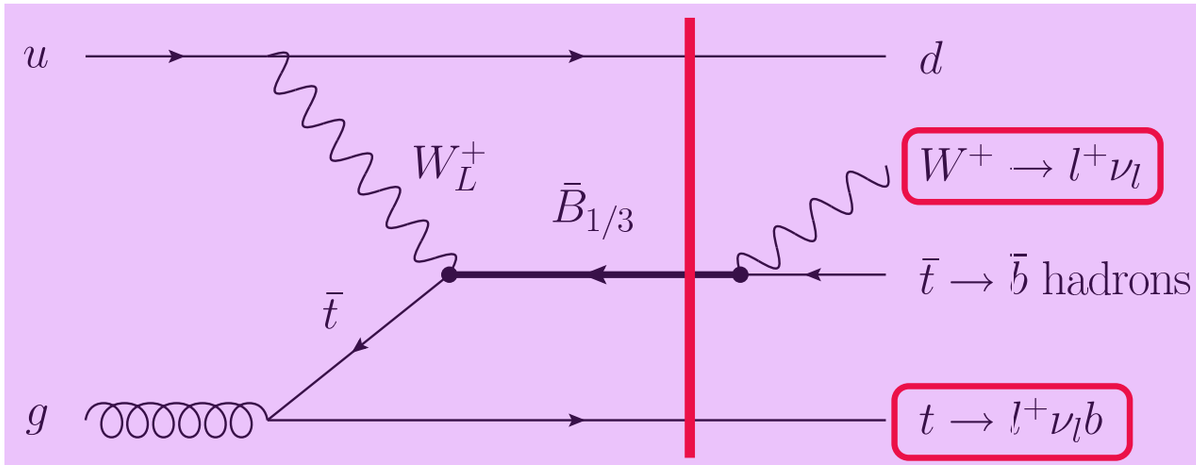
- **Coupling :** $\pi_- \bar{t}_R \lambda_T T_{5/3} + \pi_+ \bar{t}_R \lambda_B B + \text{h.c.}$

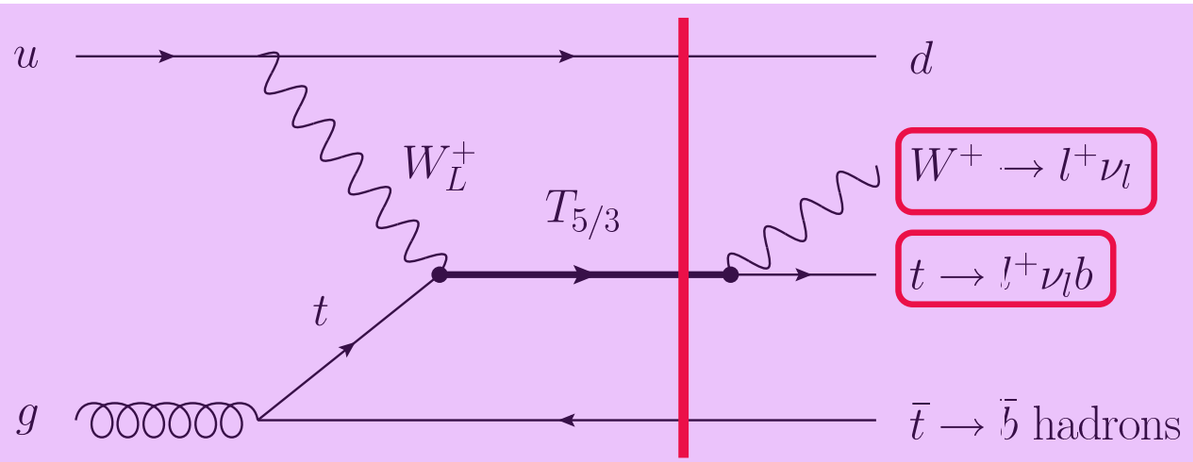
- **In explicit 5D models :** $M \lesssim 1.5$ **TeV**

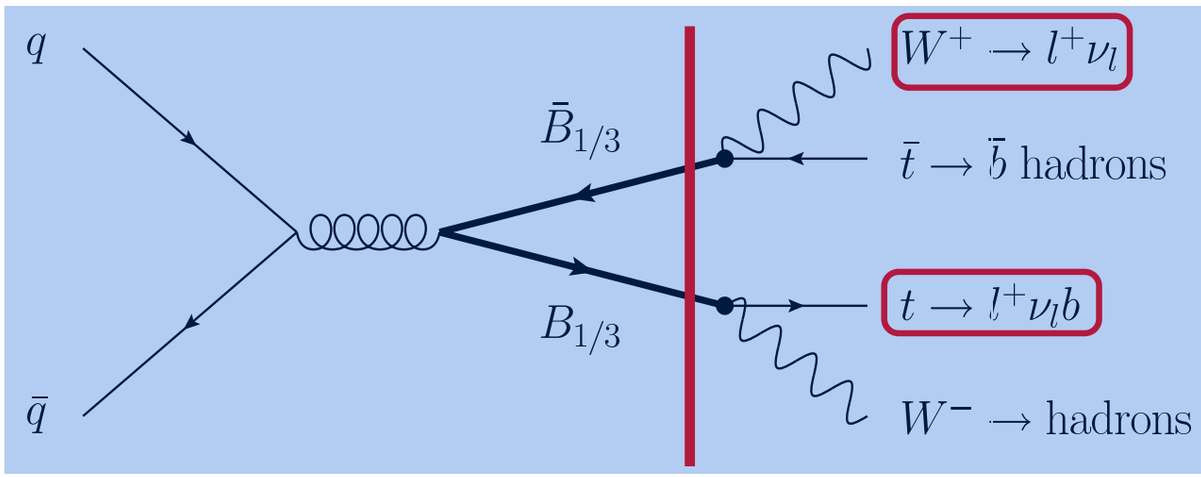
Contino, Da Rold, Pomarol

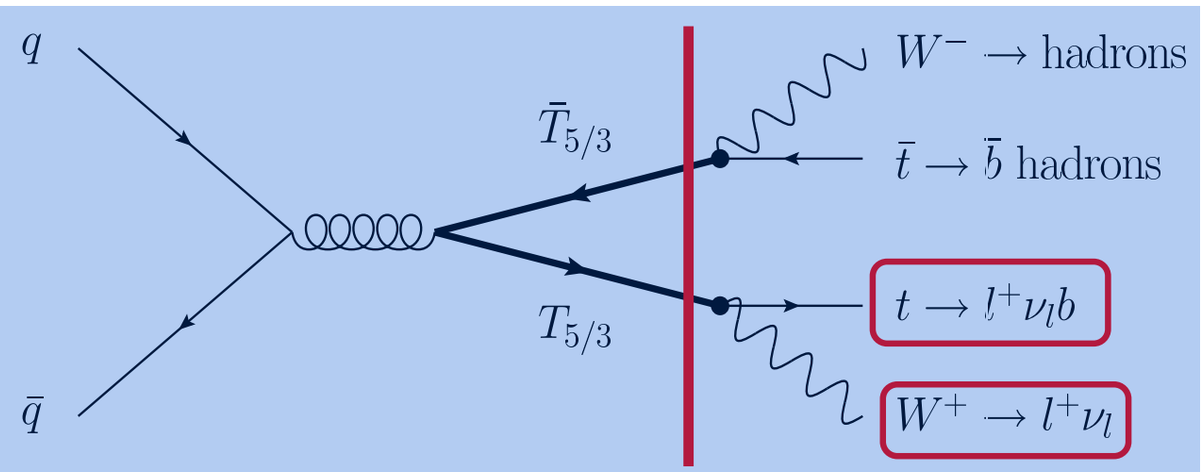
Production, diagrams

Single : model dependent ; $\sigma(++) \approx 2\sigma(--)$



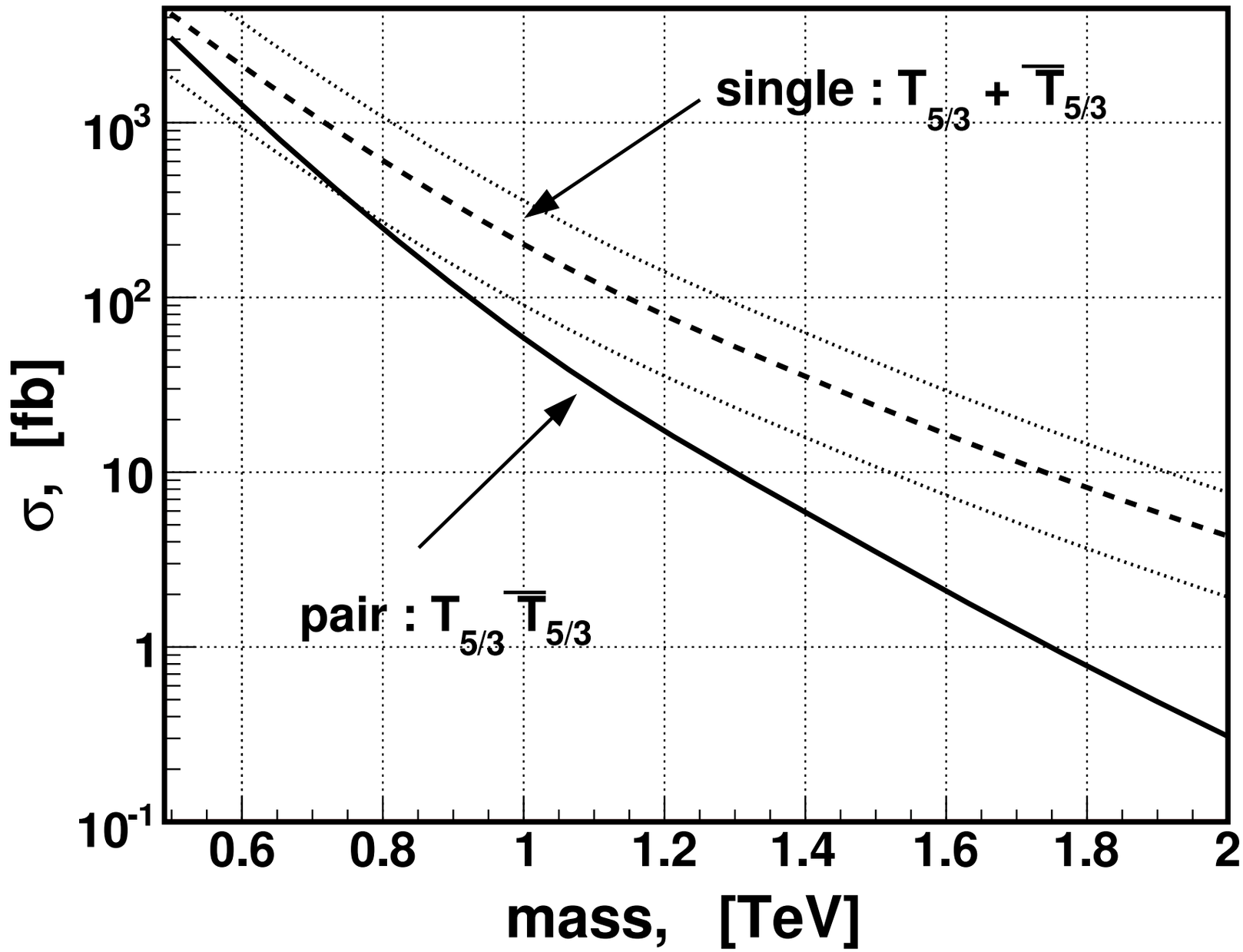






Pair : QCD

Production, cross section



Signal

$$\boxed{pp \;\longrightarrow\; l^{\pm}l^{\pm} \;+\; \not{E}_T \;+\; \text{jets}}$$

- 2 leptons backgrounds :
  $W^{\pm}W^{\pm},\ W^{\pm}W^{\pm}W^{\text{any}},\ W^{\pm}t\bar{t},\ W^{\pm}W^{\mp}t\bar{t}$

- 3 leptons (1 lost) backgrounds :
  $W^{\pm}Z,\ W^{\pm}W^{\mp}Z$

- Charge misidentification (flat 1%) :
  $W^{\pm}W^{\mp},\ t\bar{t},\ Z^{*}/\gamma^{*}$

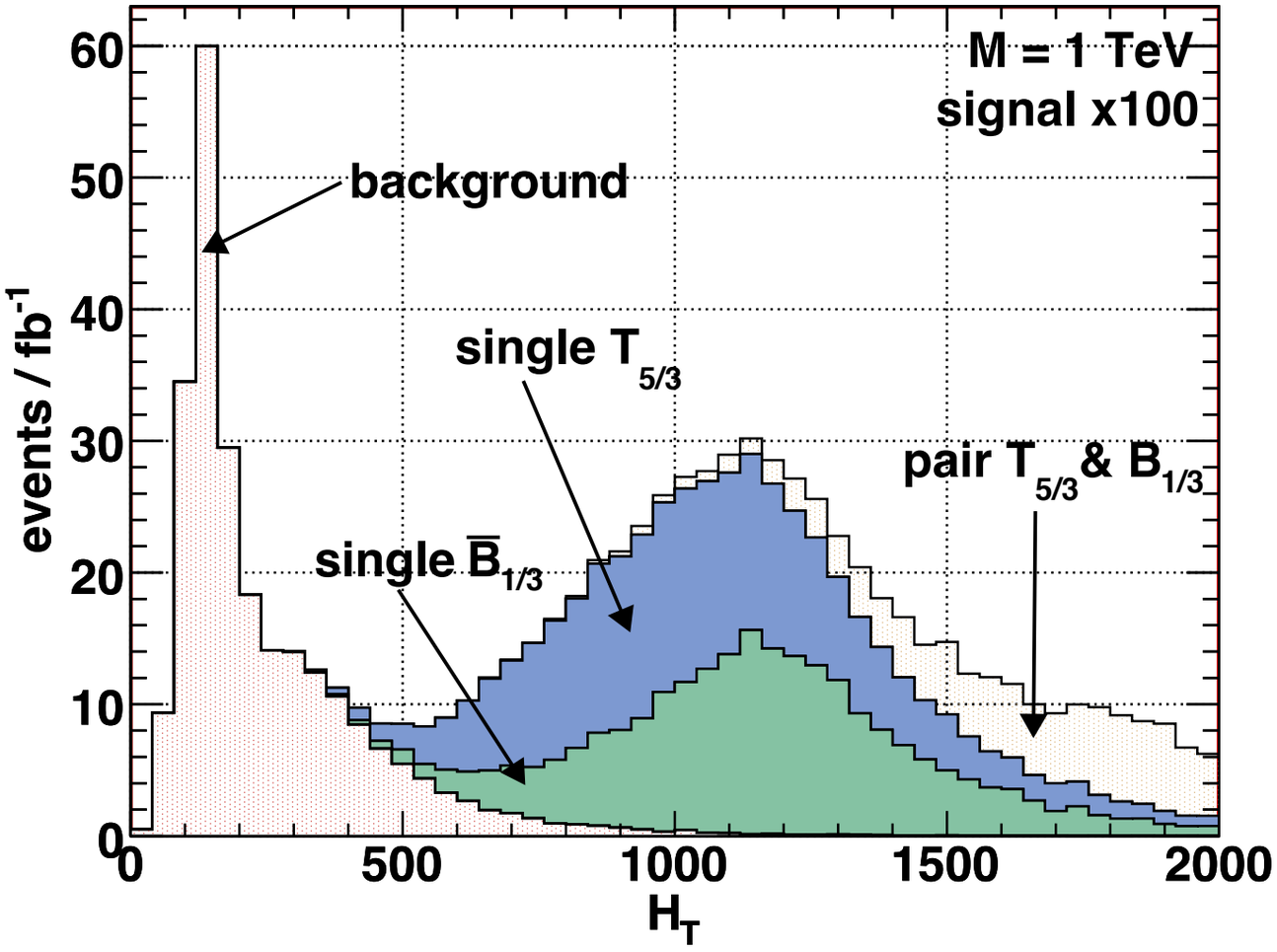
Simulation : *MadGraph/MadEvent*, *Pythia*, *MLM matching*

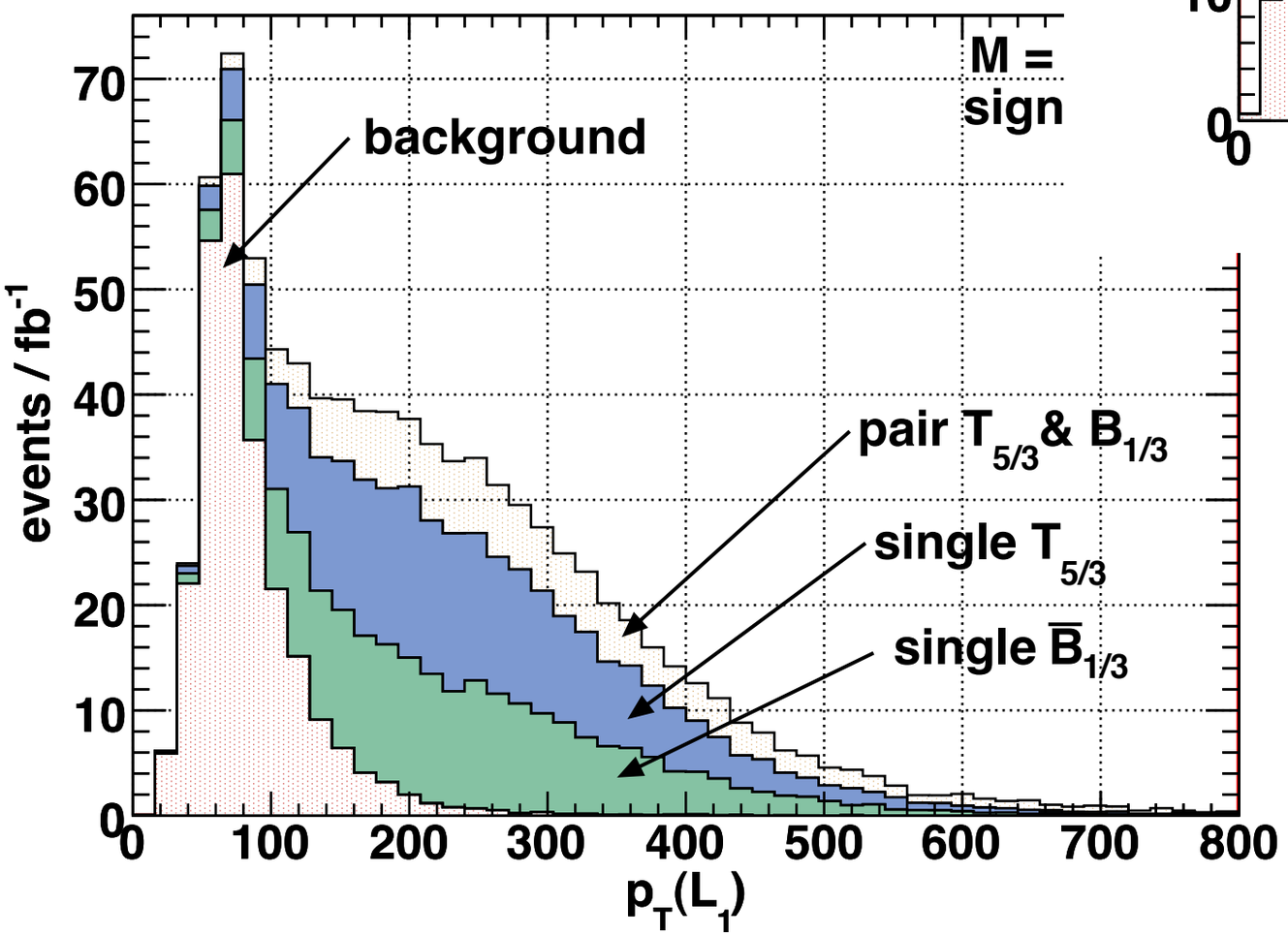
Observables

Two hard separated leptons with :

$$m_{ll} > 120 \text{ GeV}$$

$$H_T = \sum_{J,L,\not{E}_T} |p_T|$$





$$M = 1 \text{ TeV}$$

$$\begin{aligned} H_T &> 1000 \text{ GeV} \\ p_T(l_1) &> 100 \text{ GeV} \\ \not{E}_T &> 50 \text{ GeV} \end{aligned}$$

Discovery

$$T_{5/3}\ \&\ B,\ \lambda_{T,B} = 3$$

10 TeV

Mass, [TeV]	L_{disc}, [fb^{-1}]	S	B
0.5	0.072	5	0
1.0	5.5	9	3
1.5	210	22	19

14 TeV

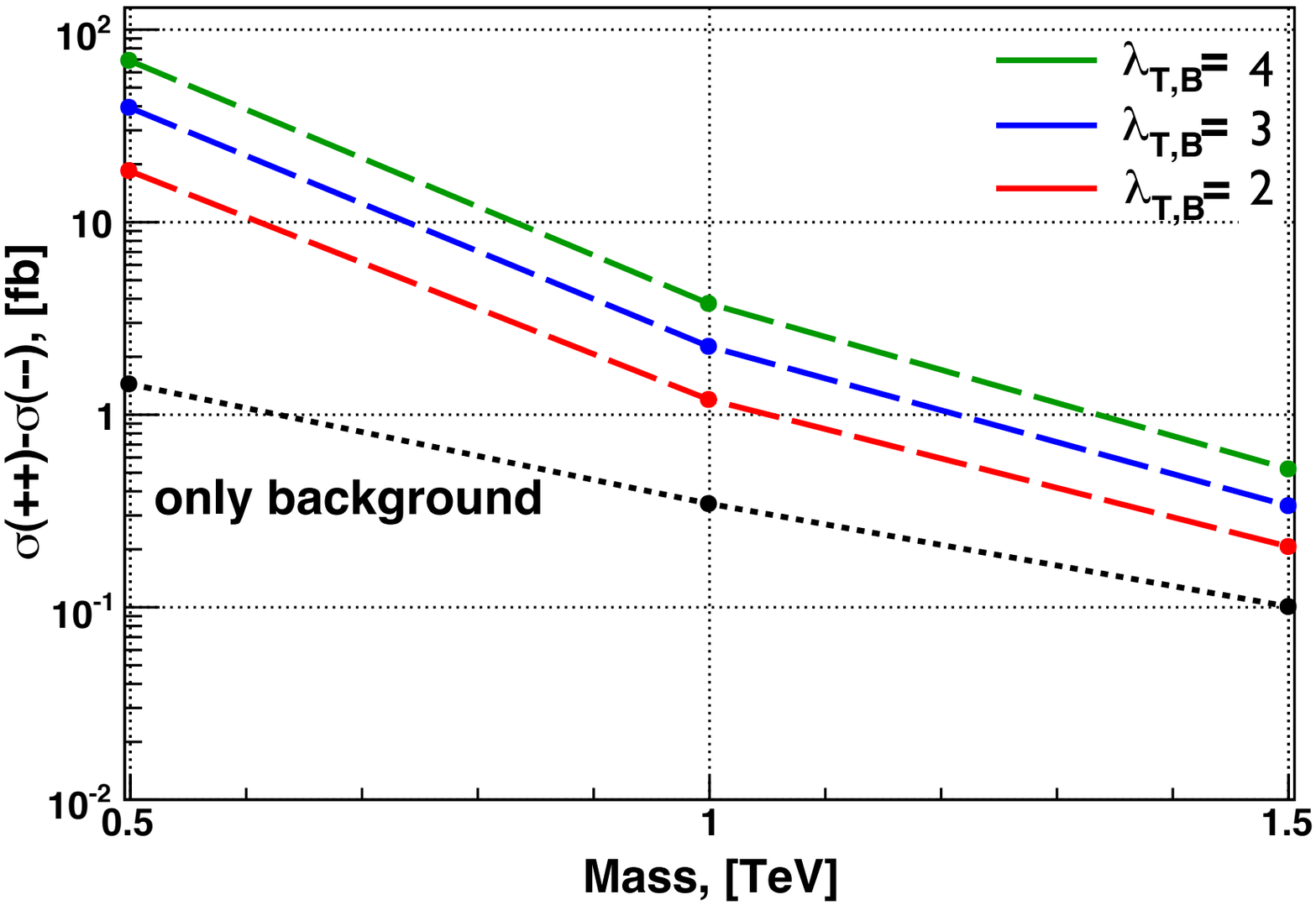
Mass, [TeV]	L_{disc}, [fb^{-1}]	S	B
0.5	0.02	5	0
1.0	1.10	8	2
1.5	26.00	17	11
2.0	330.00	28	31

Previous study, only pair
[Contino,Servant]

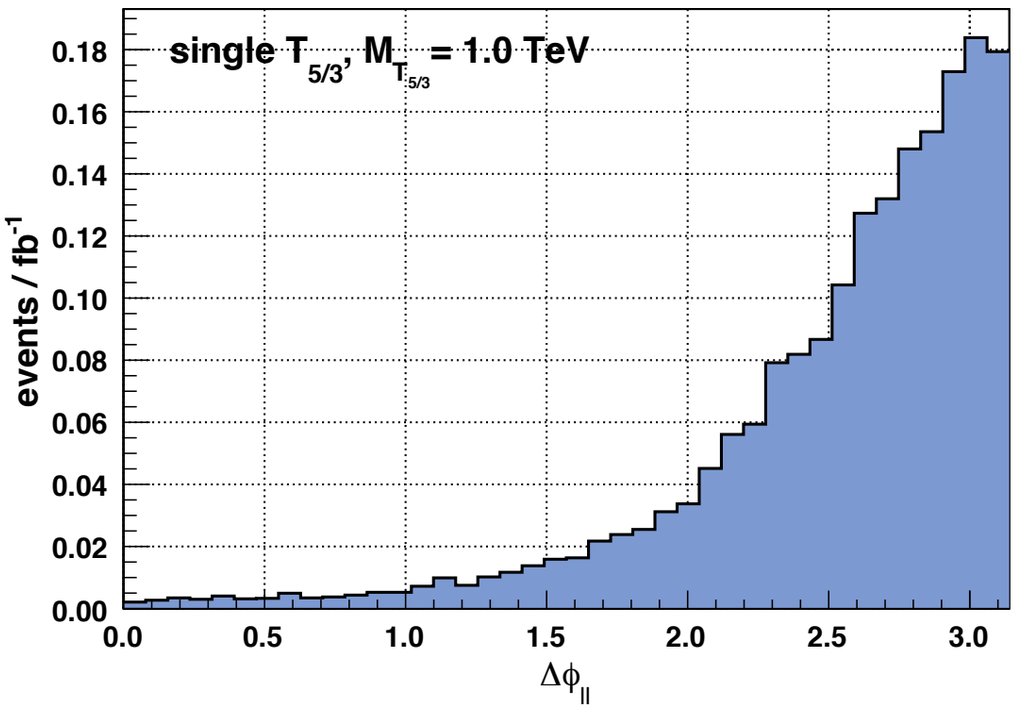
0.06
15.00

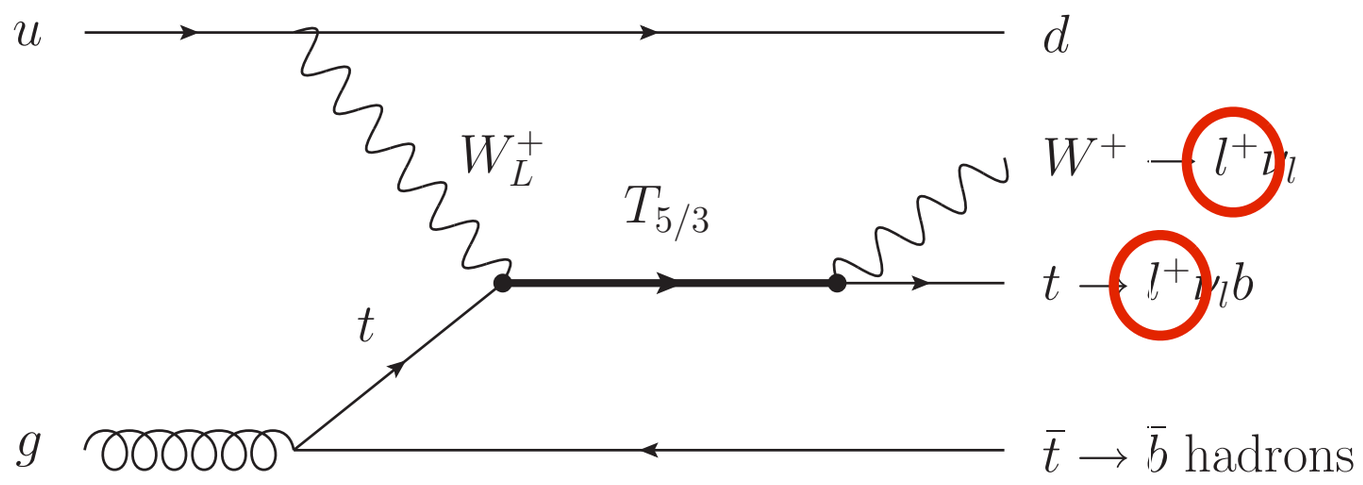
Charge asymmetry

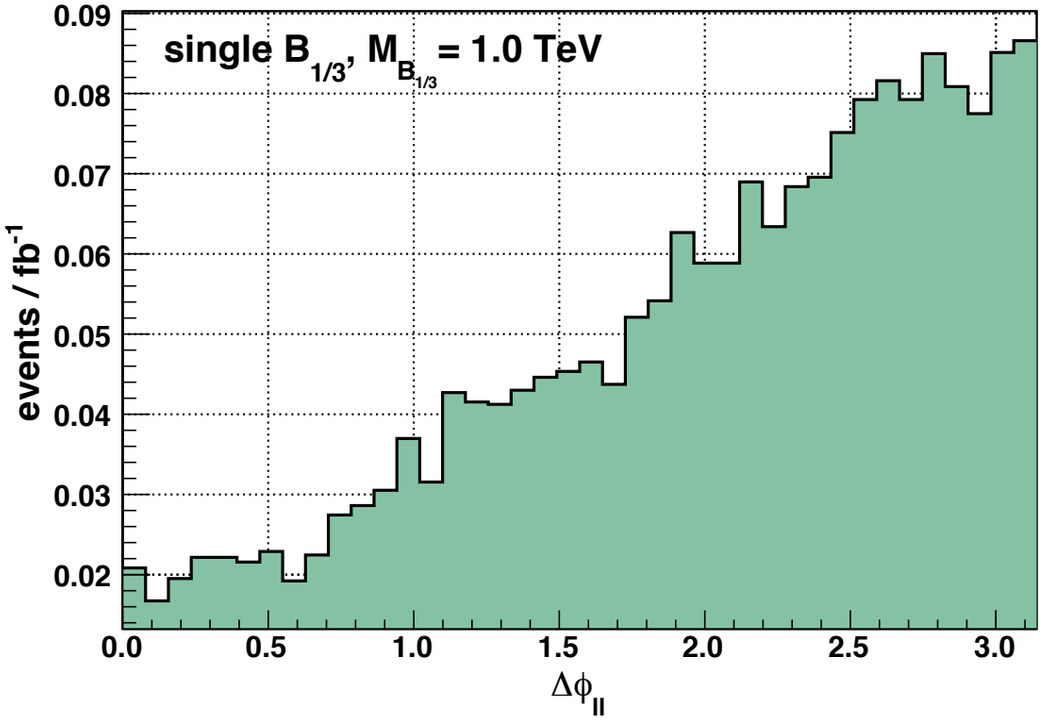
Coupling from charge asymmetry : $++ \;:\; u\ g$, $--\;:\; d\ g$

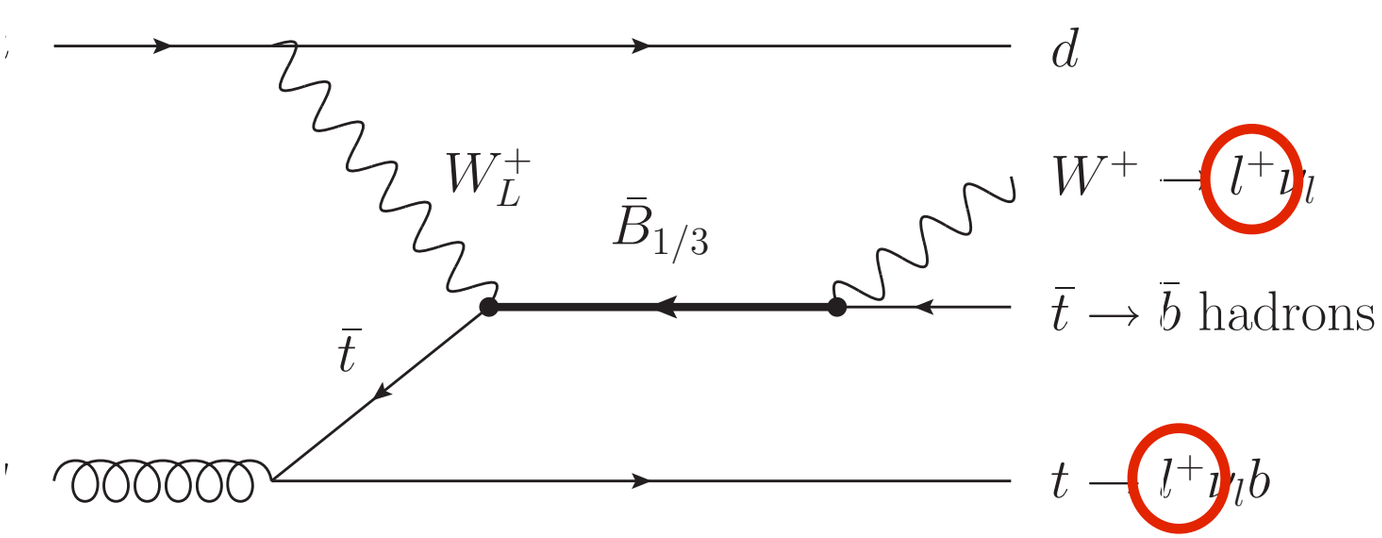


Difference between $T_{5/3}$ & B









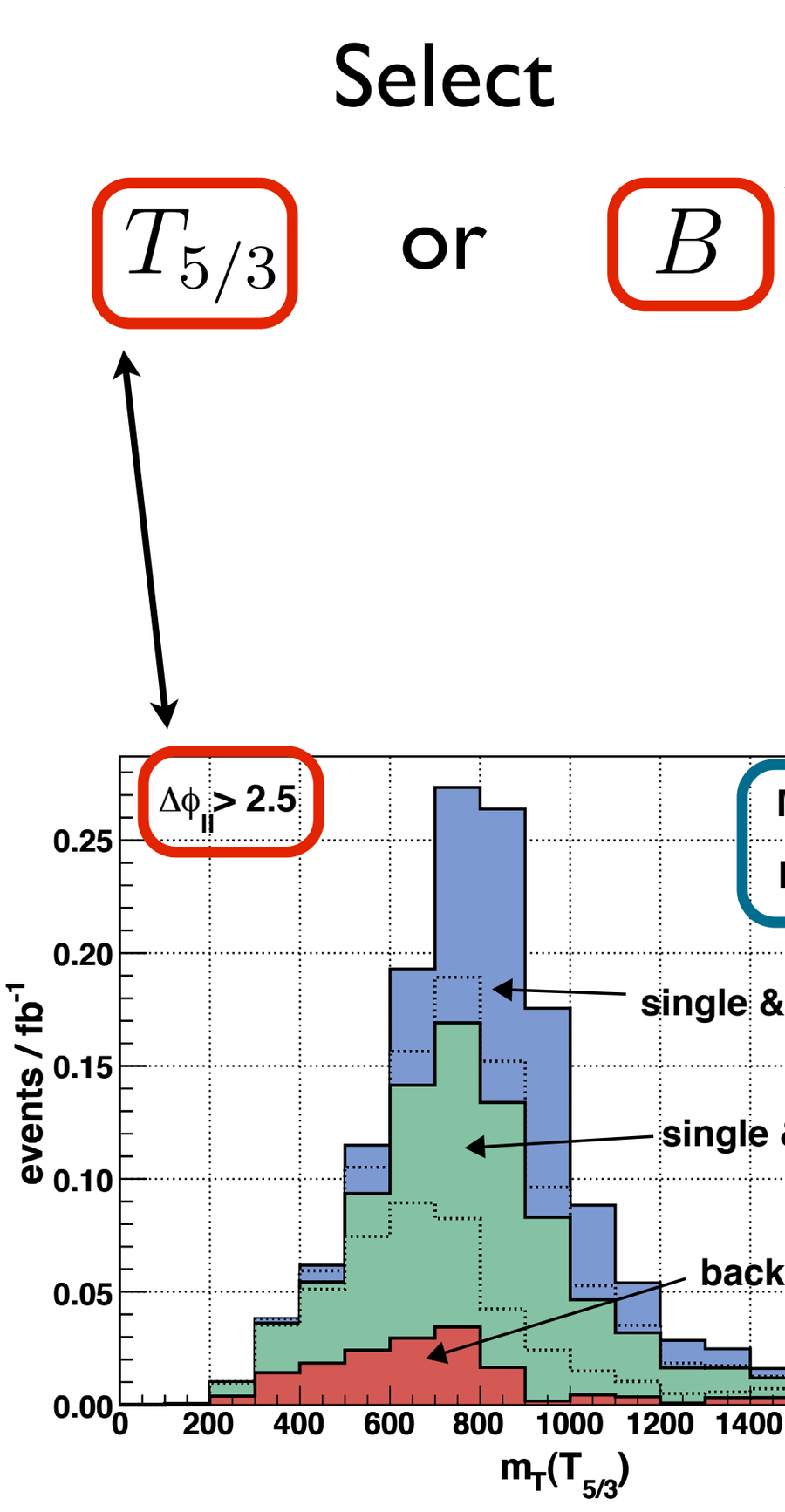
Conclusion

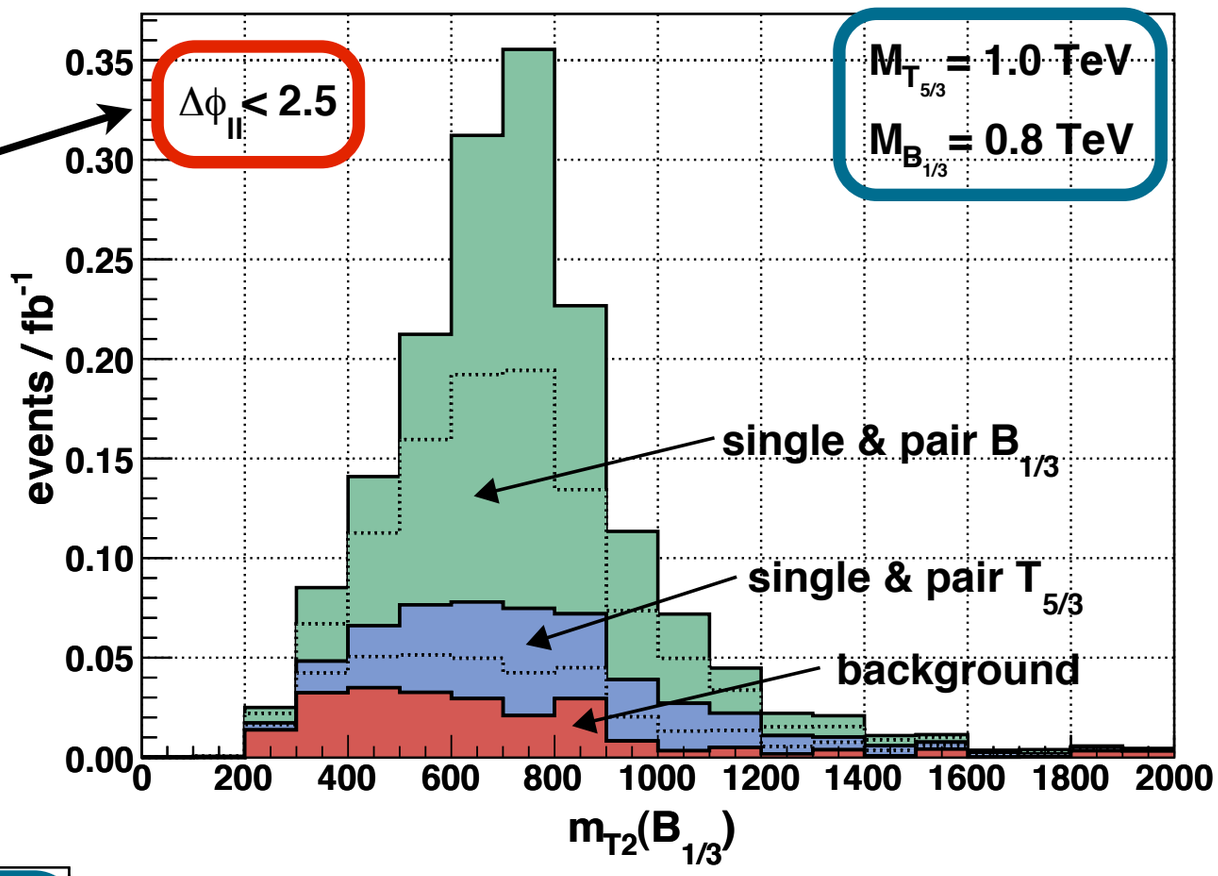
- Top partners : signature of partial compositeness
- Virtues of single production :
    - Improved discovery reach up to M ~ 1.5 TeV
    - Measure of coupling, mass and charge
    - Distinguish top partners from other NP
- Explicit 5D realisations would be observed @ LHC

Appendix : mass of $T_{5/3}$ & B

Select

$T_{5/3}$ or B





B use m_{T2}

$T_{5/3}$ use m_T

Appendix, Forwad jet

Eff. 65% ; fake : 20%