FINDING LIGHT STOPS WITH FAT JETS

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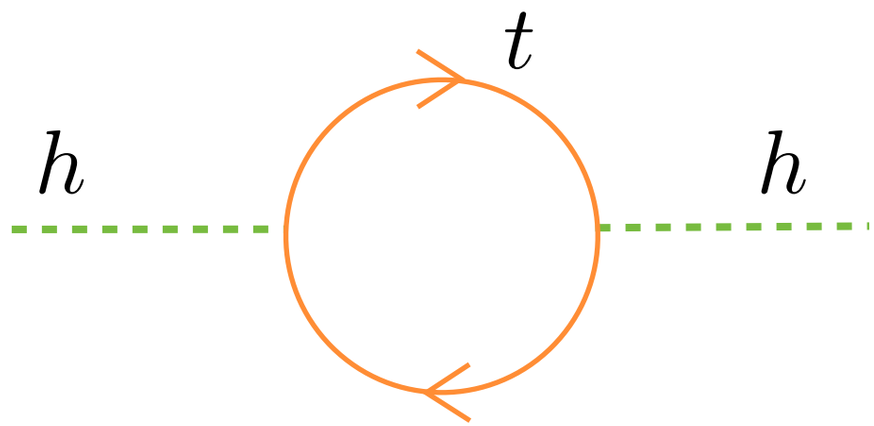
WORK IN PROGRESS WITH DAVID E. KAPLAN AND KEITH REHERMANN

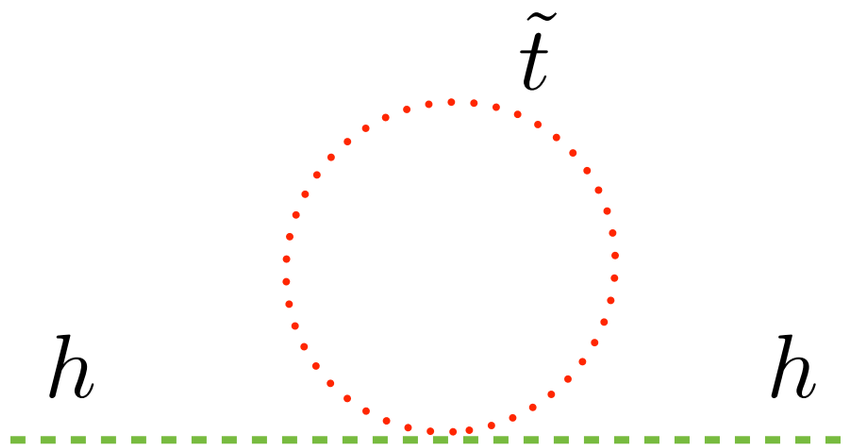
PROBING NATURAL SUSY

- If hierarchy problem is solved by SUSY, stop must be light

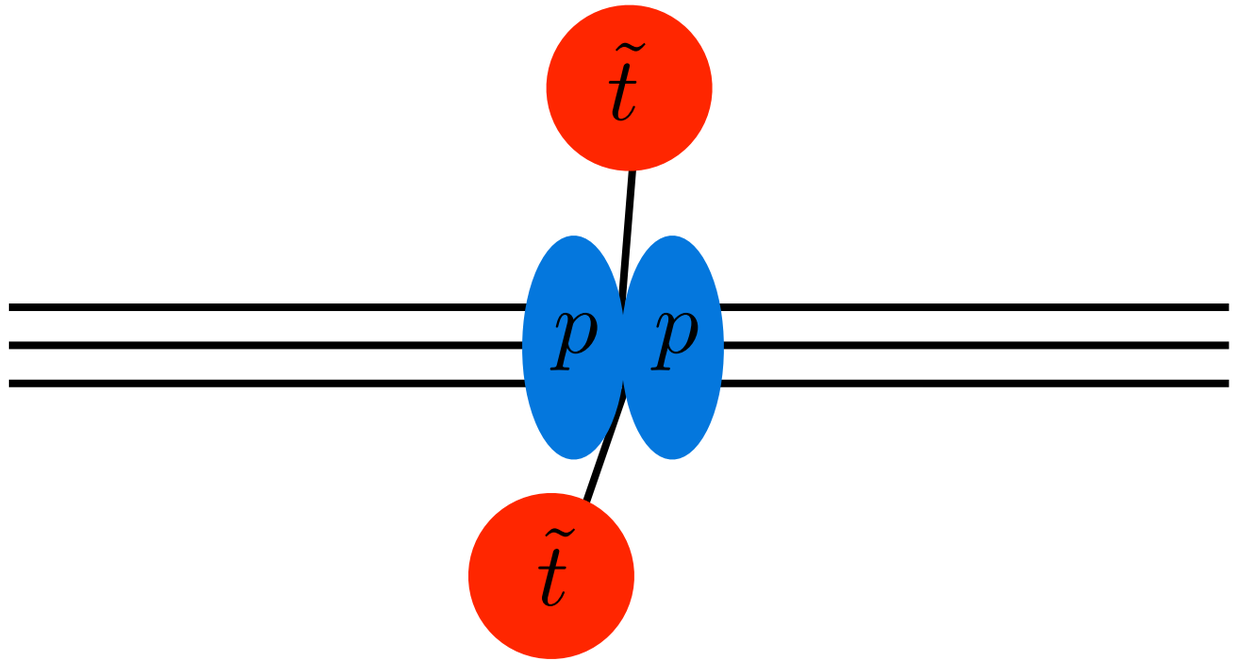


- R-parity and neutralino LSP is well motivated

- Consider minimal spectrum with $m_{\tilde{t}} > m_t + m_{\chi^0}$



STOP EVENTS



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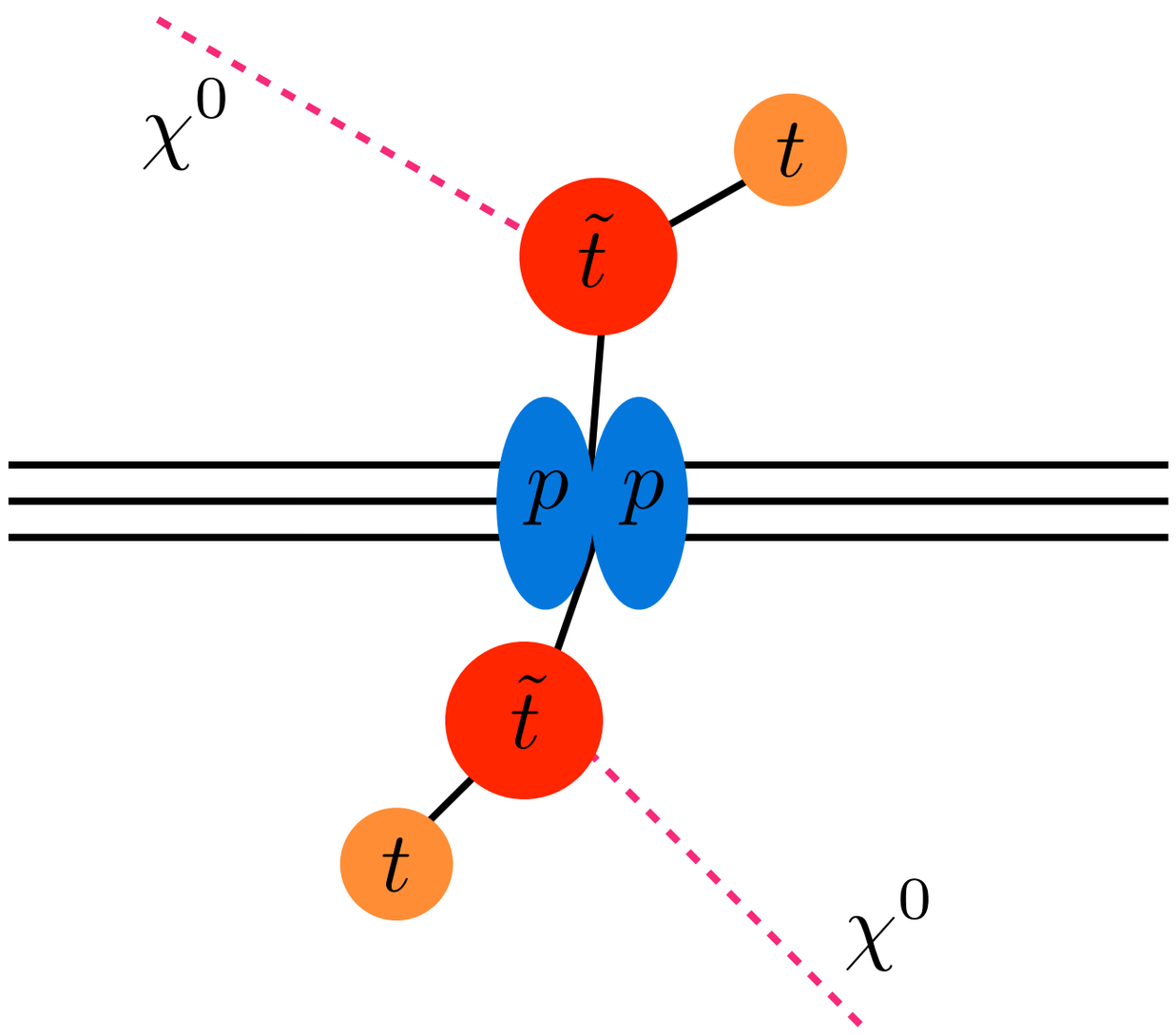

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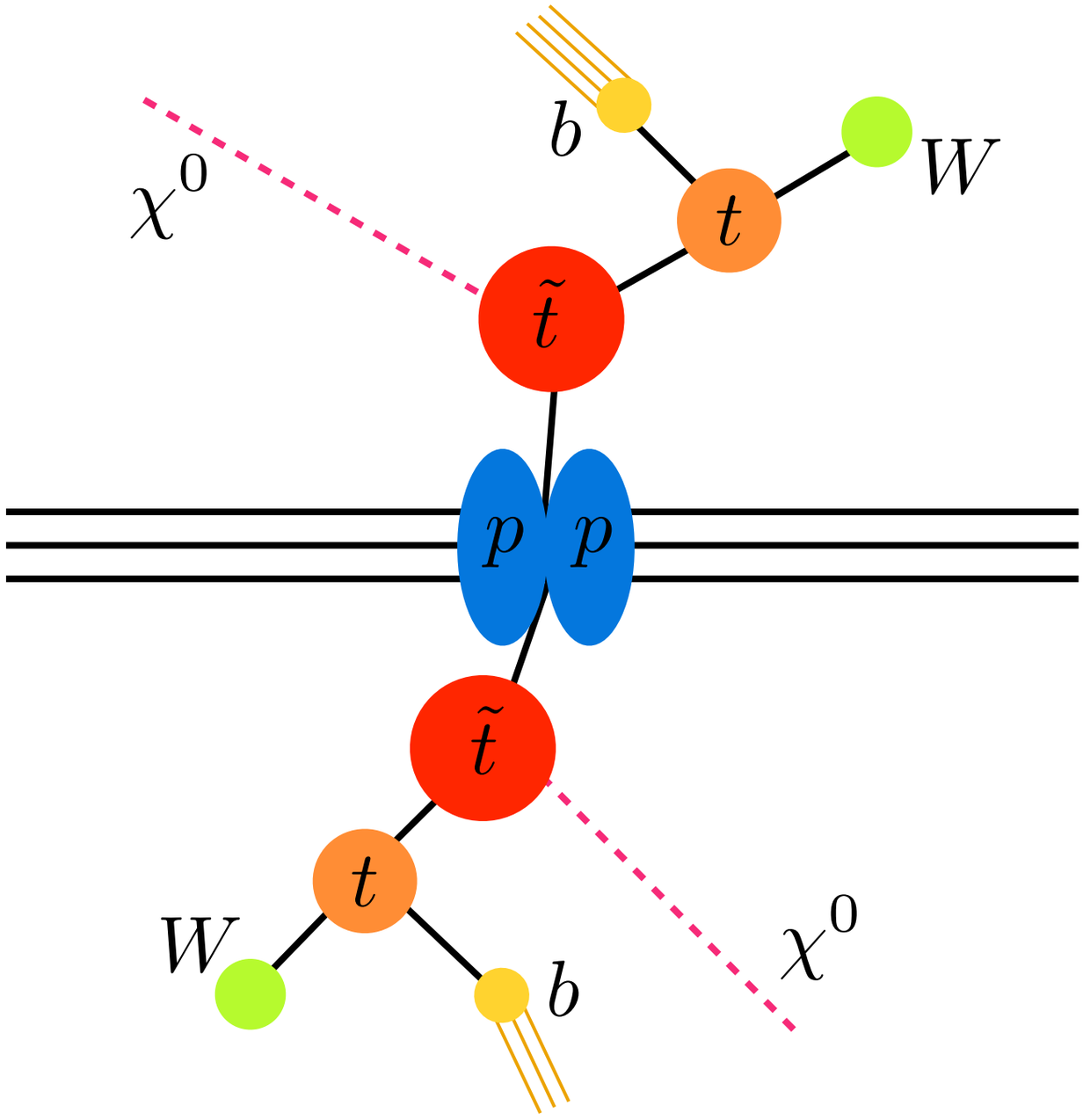

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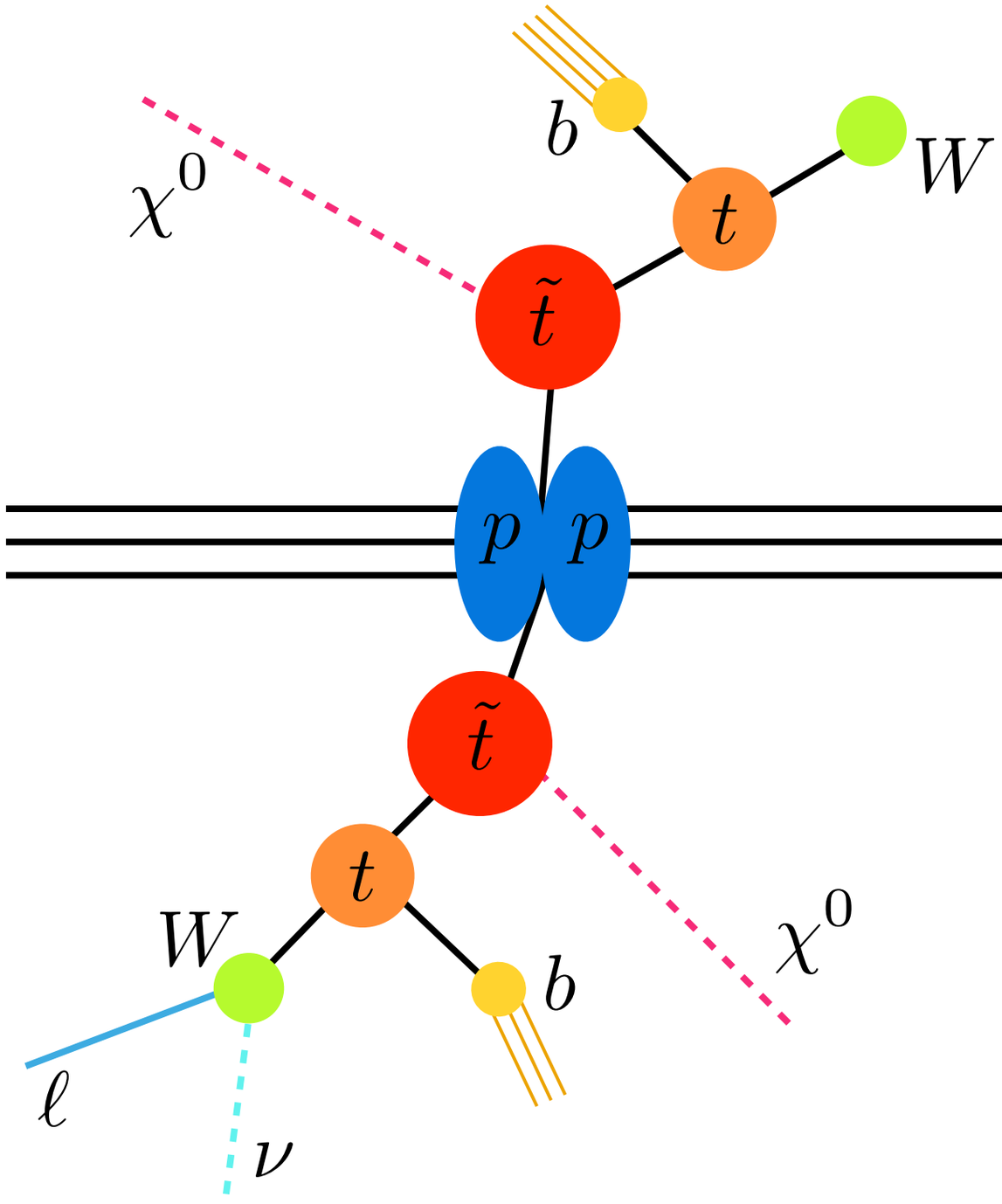

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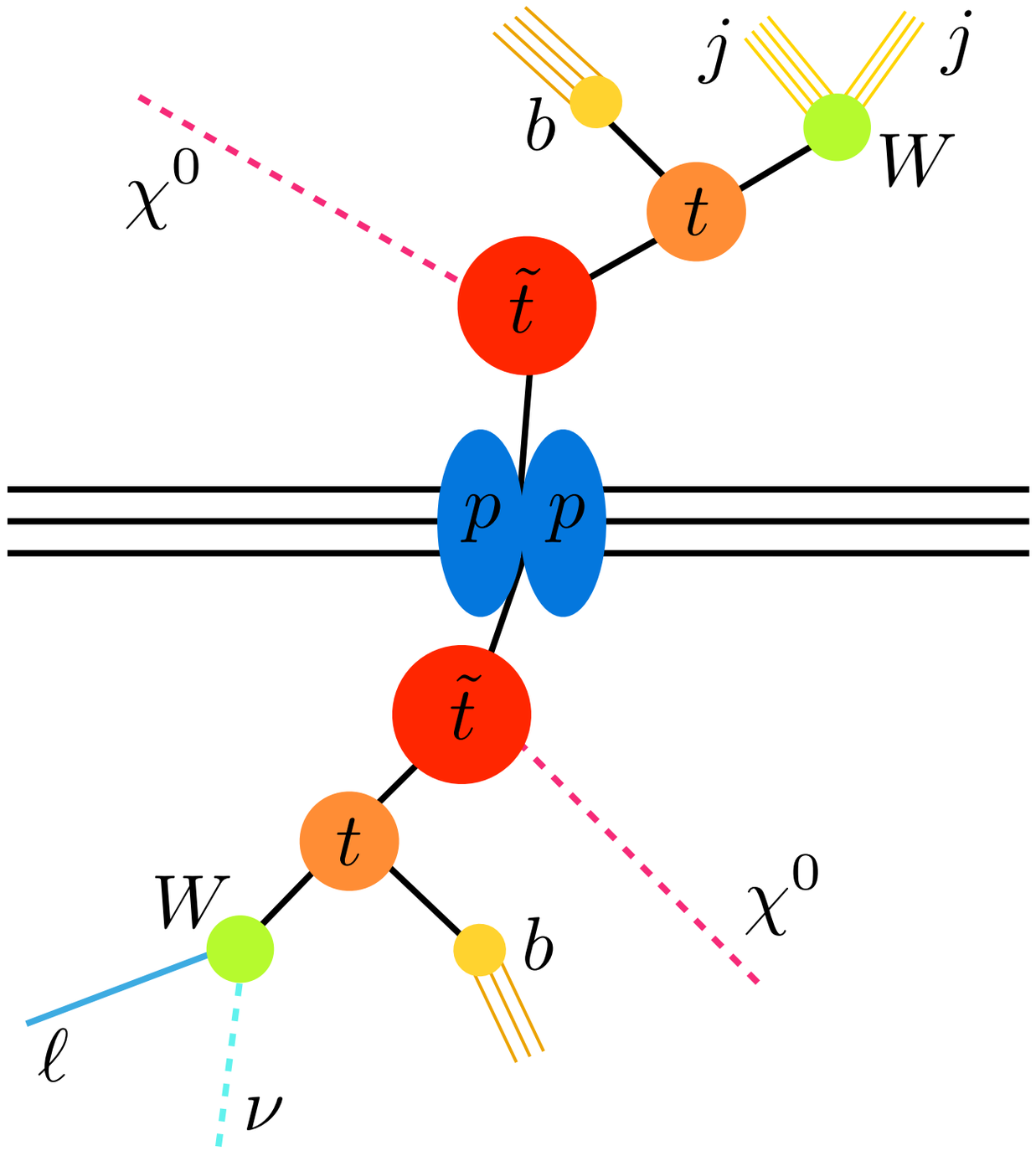


CURRENT LHC SEARCHES

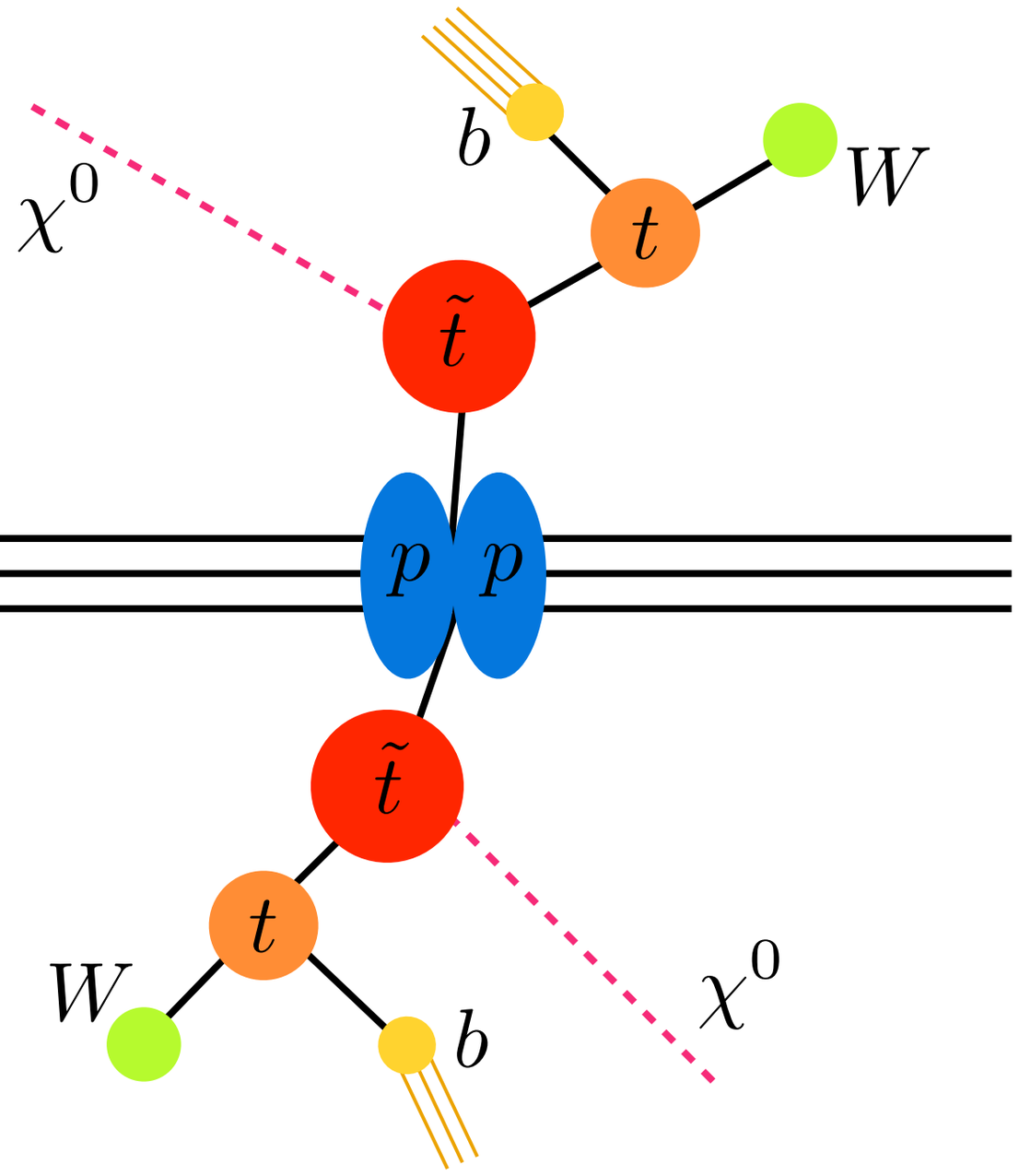
- ATLAS search for (semi-leptonic) tops and missing energy with 1 fb^{-1} places no bound on scalar tops. **ATLAS 1109.4725 [hep-ex].**

- Several other searches with leptons are potentially sensitive: **e.g. CMS 1107.1870, ATLAS 1109.6606.**

- Also have searches with n b's + jets + missing energy, not optimized for tops in final state: **e.g. CMS 1106.3272, ATLAS-CONF-2012-003.**

- Theory papers have looked all searches to place bounds; still nothing for our scenario. **Papucci et. al. 1110.6926, Brust et. al. 1110.6670, Essig et. al. 1110.6443, Y. Katz et. al. 1110.6444.**

FULLY HADRONIC STOPS



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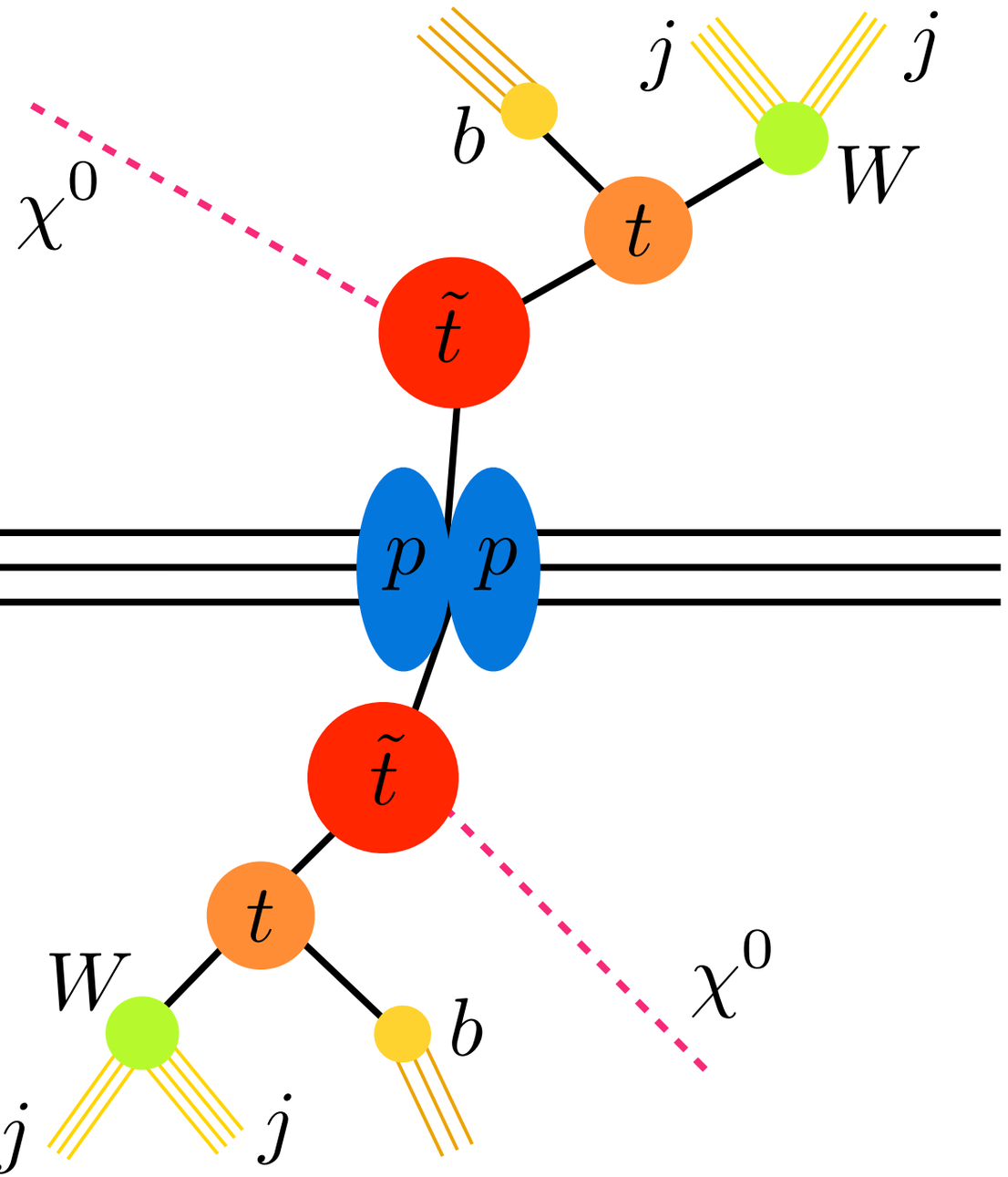

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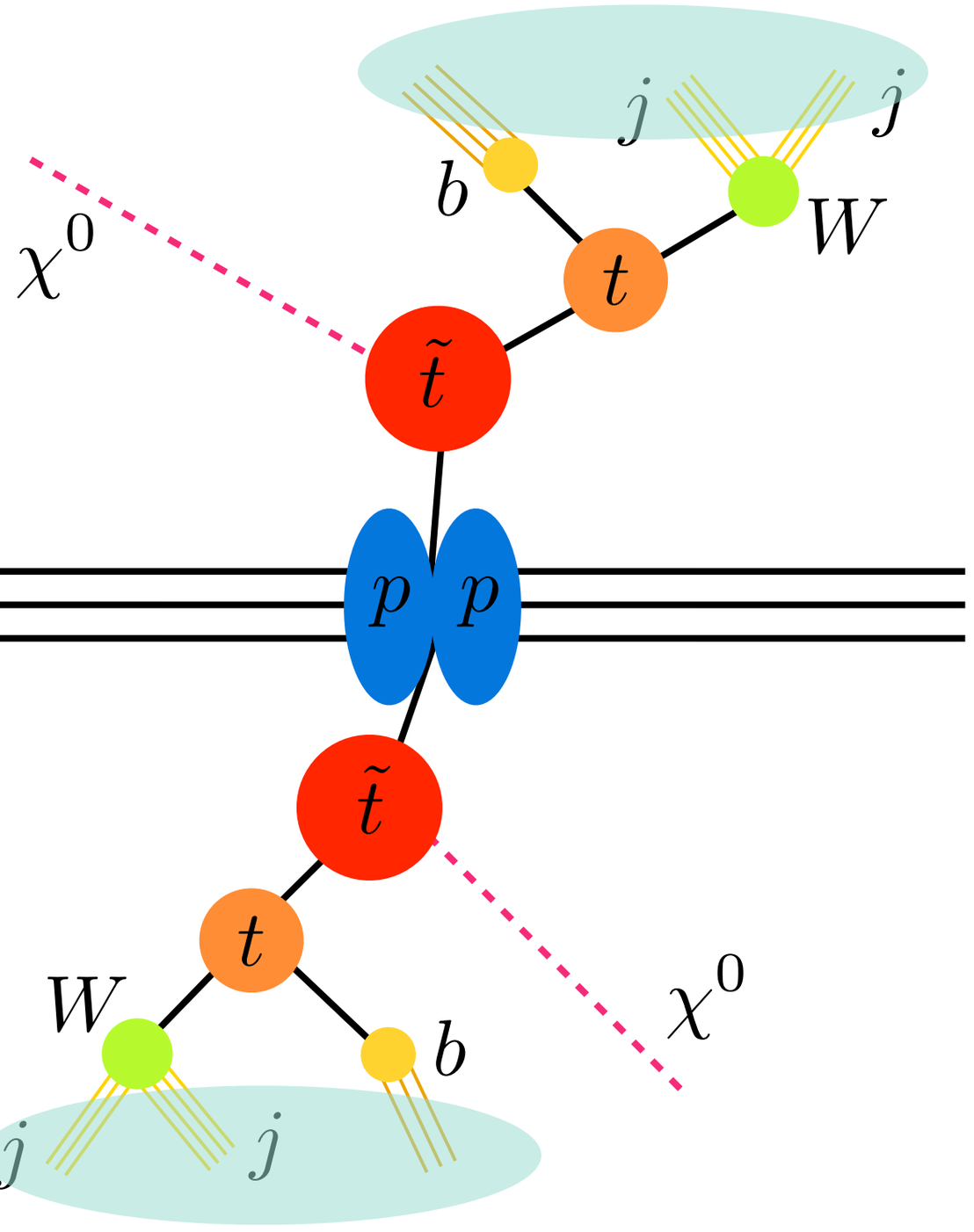
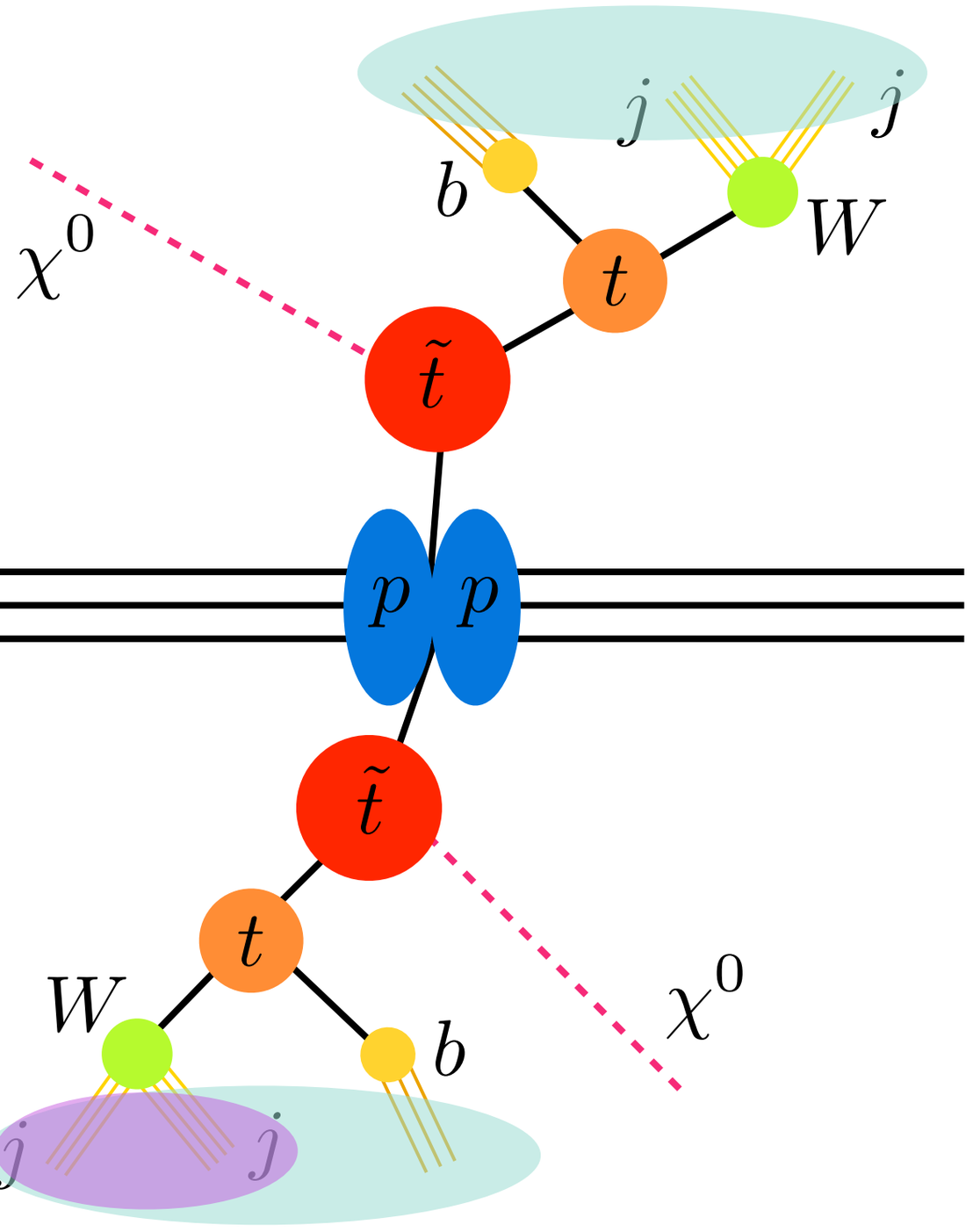


Fat jets
R=1.2

FULLY HADRONIC STOPS



Fat jets
R=1.2

BACKGROUNDS AND CUTS

Backgrounds

Cuts

- Veto on isolated leptons, tau's, and bizarre missing energy events.

BACKGROUNDS AND CUTS

Backgrounds

- QCD
- V + $b\bar{b}$ + jets
- V + jets
- Tops + jets

Cuts

- Veto on isolated leptons, tau's, and bizarre missing energy events.

BACKGROUNDS AND CUTS

Backgrounds

- ~~QCD~~
- V + $b\bar{b}$ + jets
- V + jets
- ~~Tops + jets~~

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- Veto on isolated leptons, tau's, and bizarre missing energy events.
- Missing energy > 175 GeV

BACKGROUNDS AND CUTS

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- ~~$V + b\bar{b}$ + jets~~
- ~~V + jets~~
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- Missing energy > 175 GeV
- One HEPTopTagged fat jet

  Plehn et. al., 0802.4142.

BACKGROUNDS AND CUTS

Backgrounds

- ~~QCD~~
- ~~V + $b\bar{b}$ + jets~~
- ~~V + jets~~
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Cuts

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- Missing energy > 175 GeV
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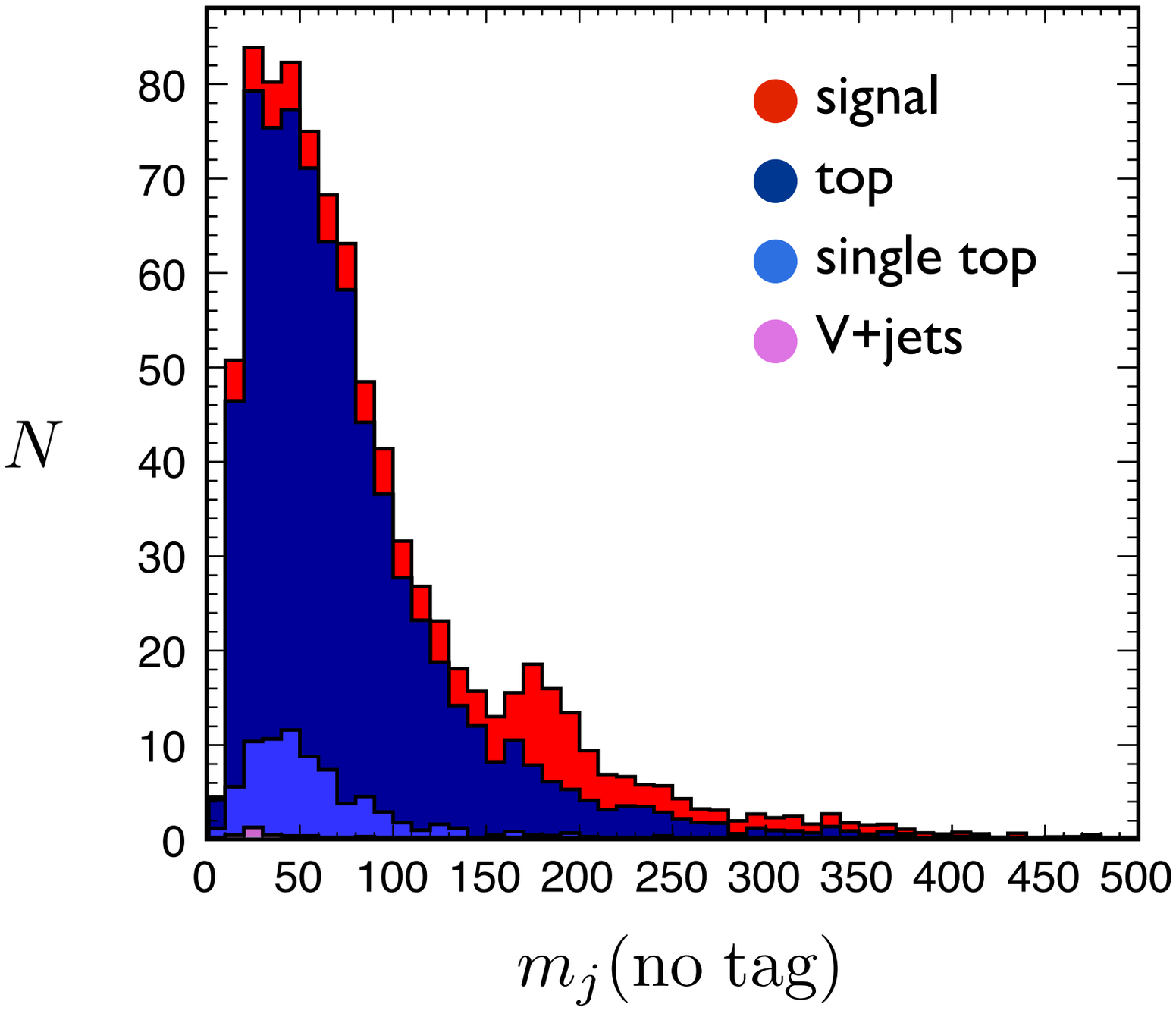
- Opposite jet is *b*-tagged

GOOD SIGNAL TO BACKGROUND



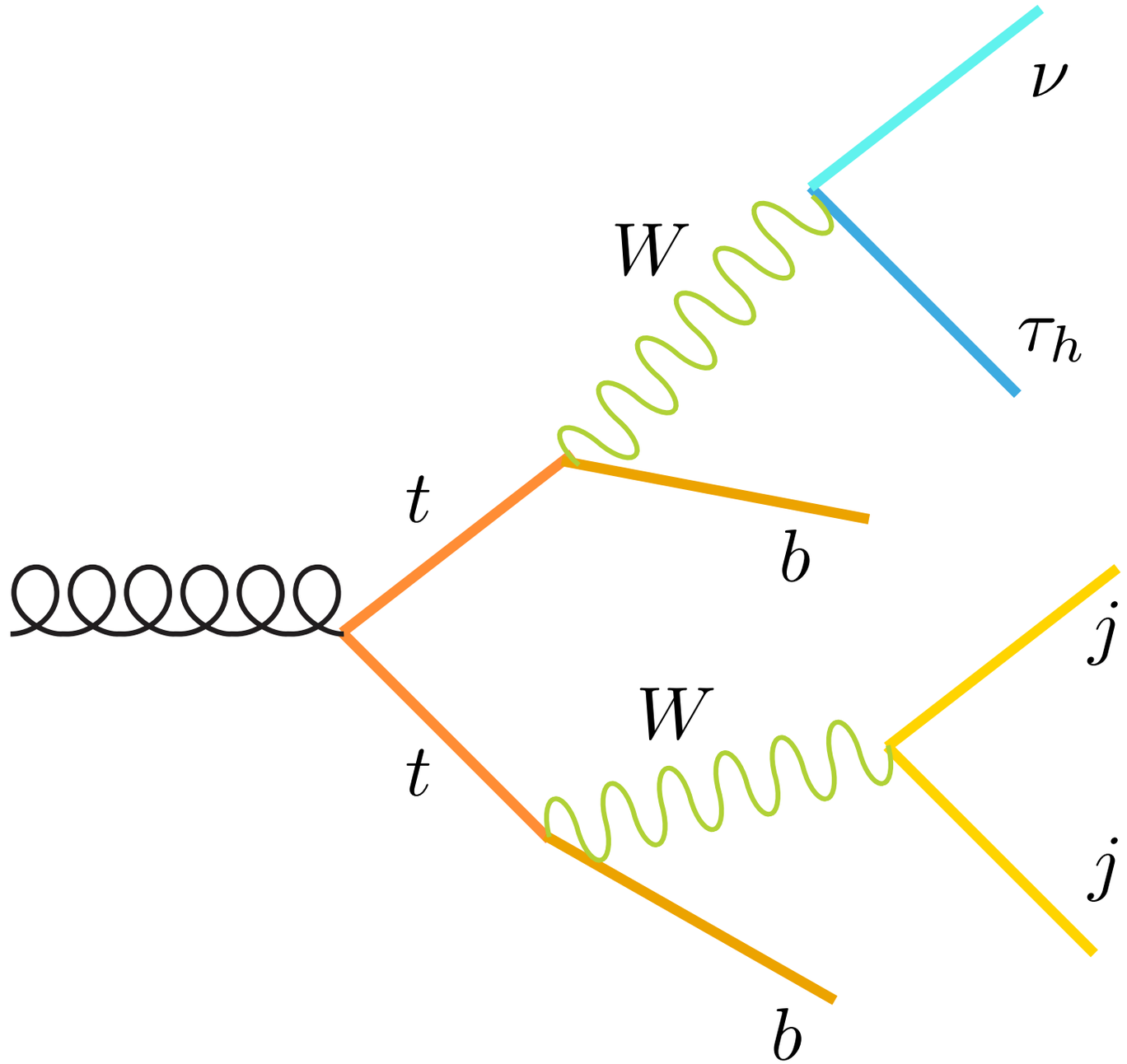
$$\sqrt{s} = 8\,\text{TeV}$$

$$\mathcal{L} = 20\,\text{fb}^{-1}$$

$$m_{\tilde{t}} = 440\,\text{GeV}$$

$$m_{\chi} = 100\,\text{GeV}$$

KINEMATIC CUTS



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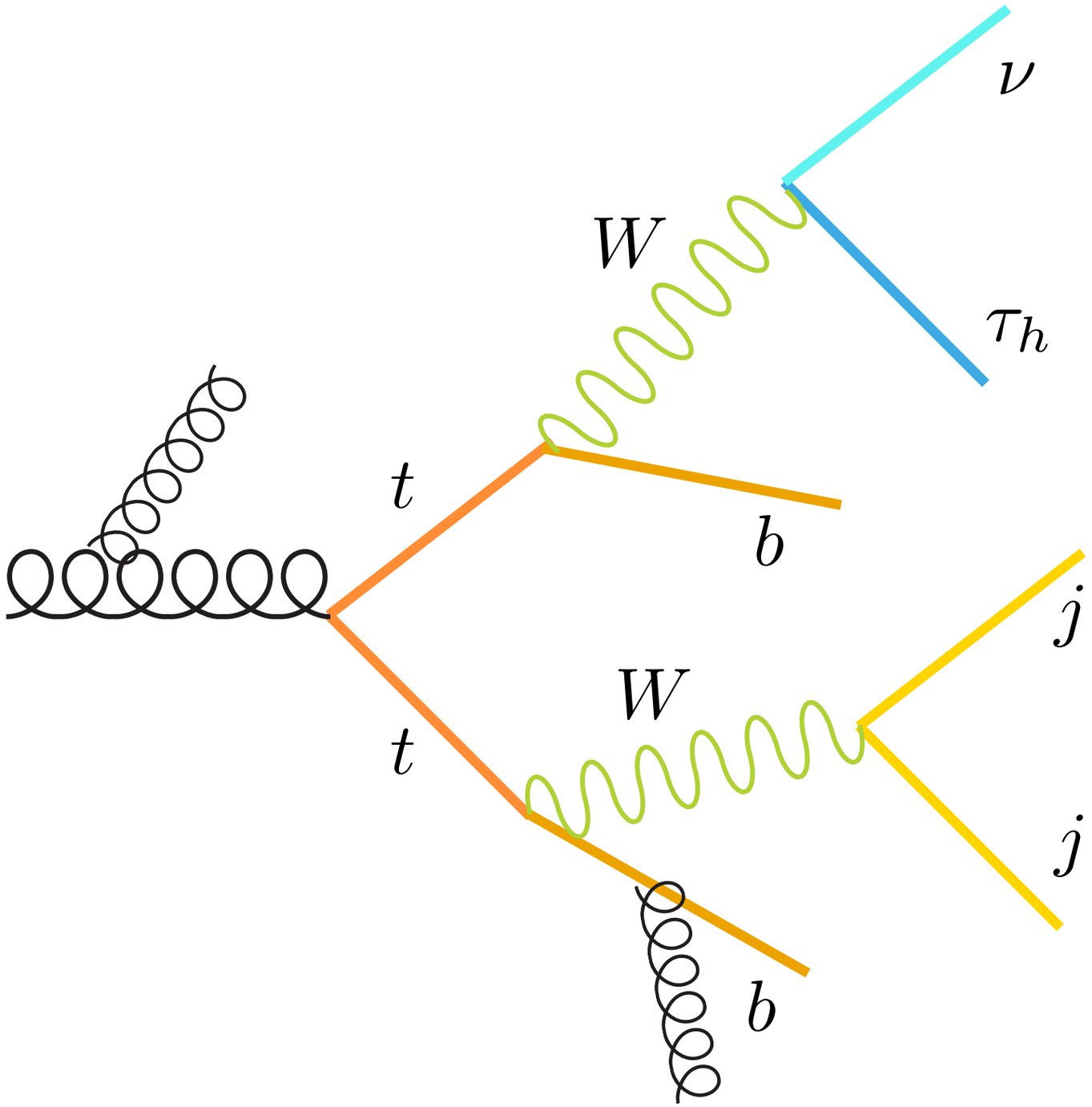
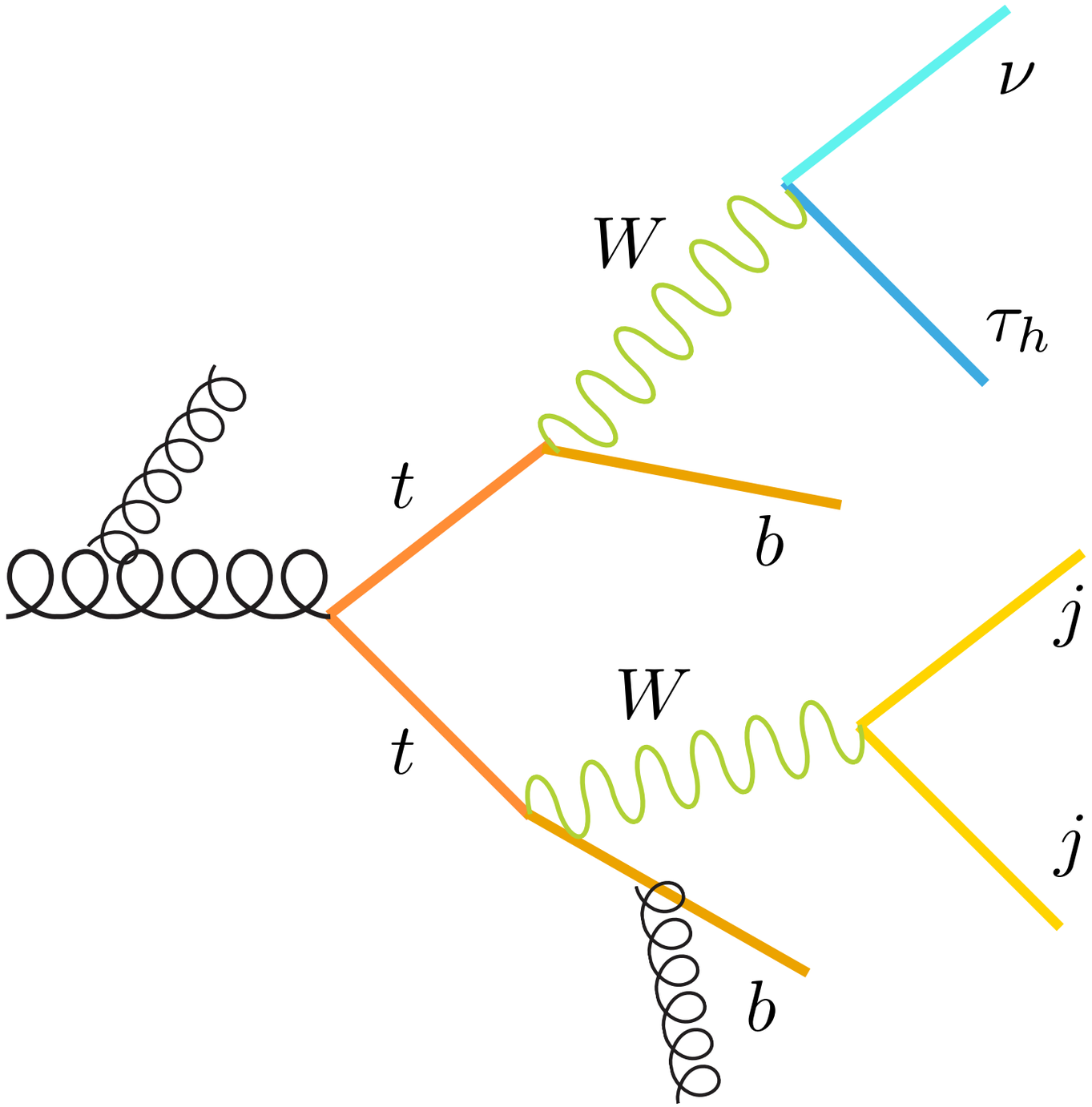


KINEMATIC CUTS

- Transverse mass of missing energy with both fat jets > 200 GeV

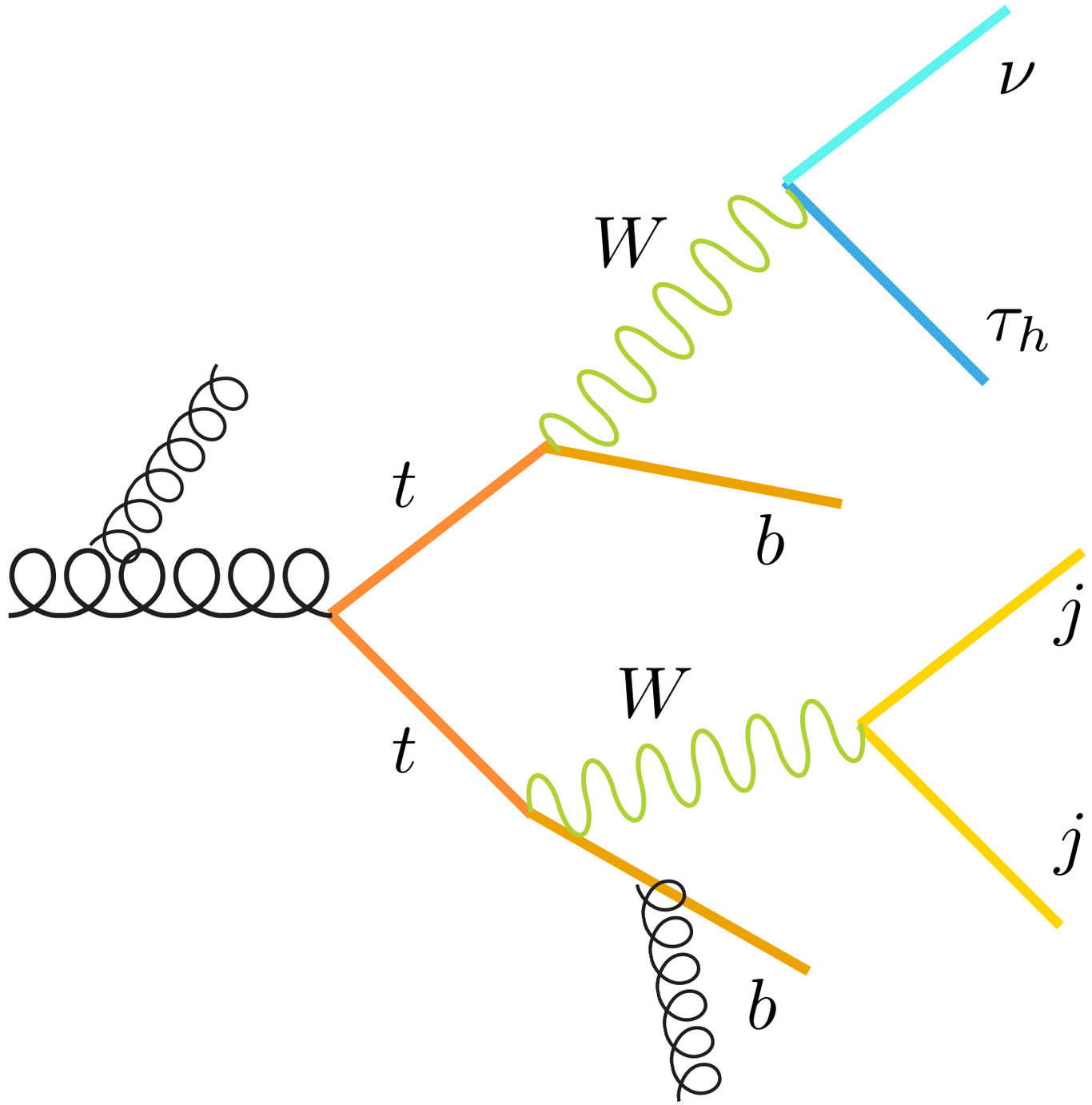


KINEMATIC CUTS

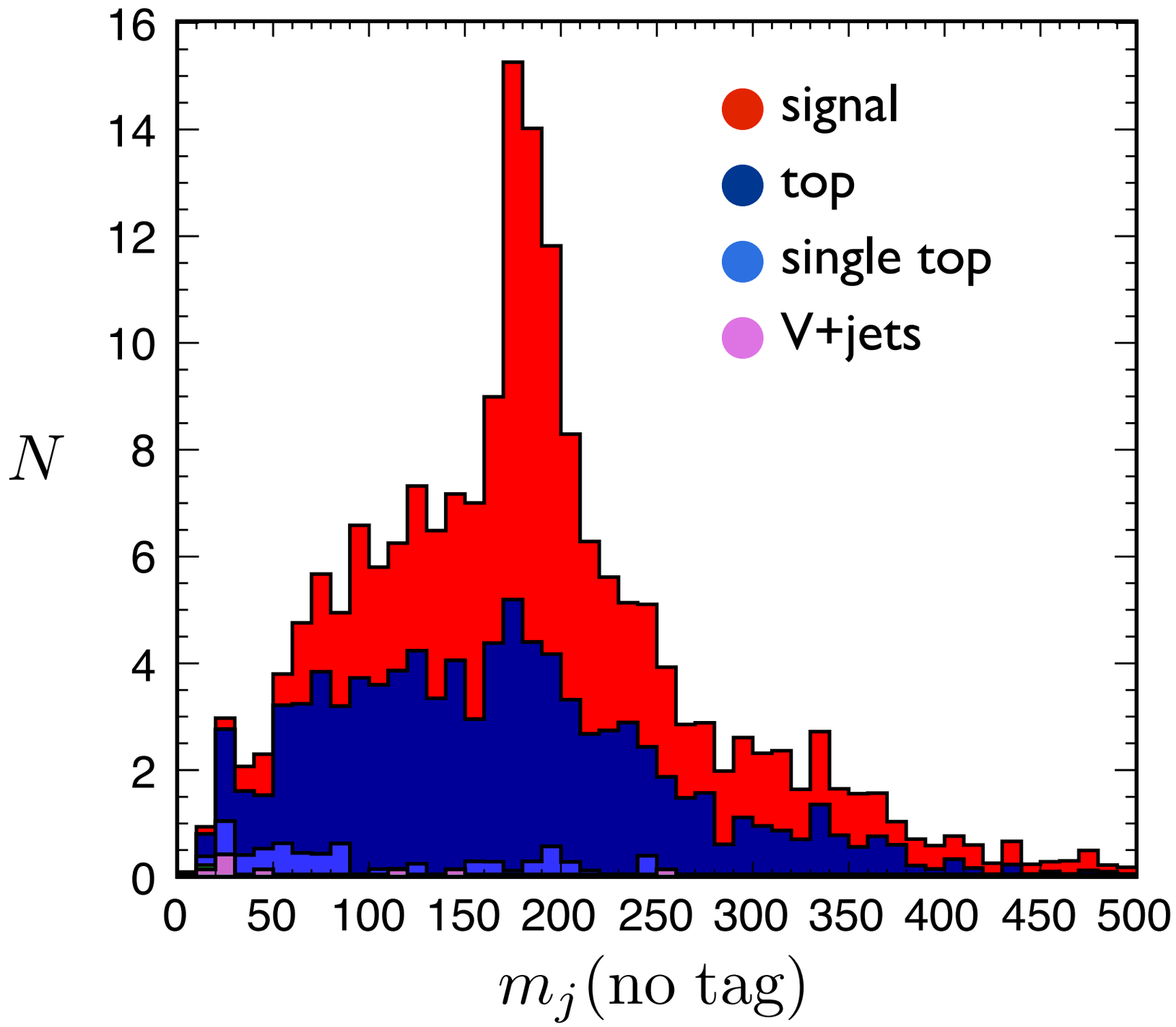
- Transverse mass of missing energy with both fat jets > 200 GeV

- mT2 > 200 GeV

  Lester et. al., hep-ph/9906349,
  Conlon et. al., hep-ph/0304226.



CLEAR SIGNAL DISCRIMINATION



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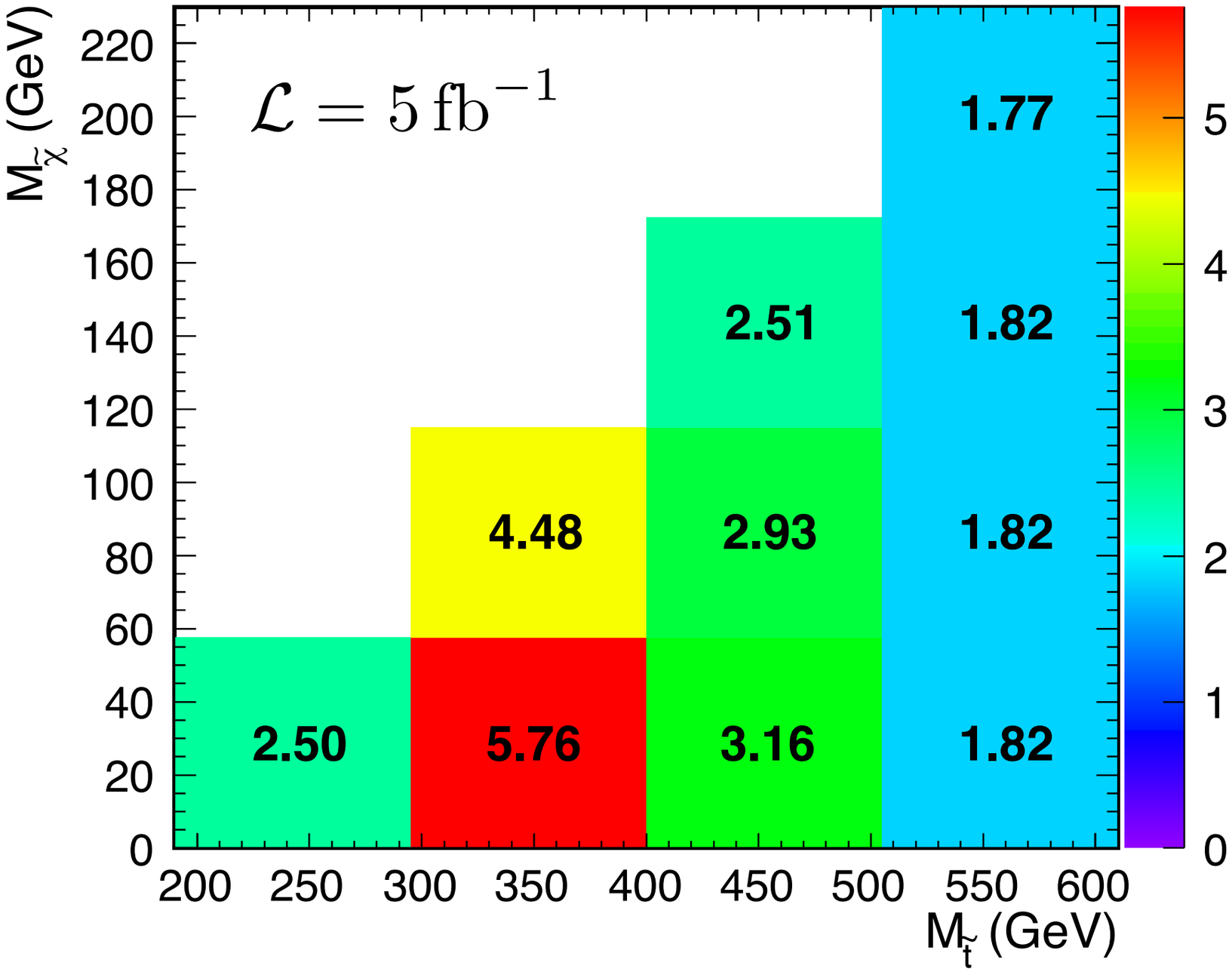
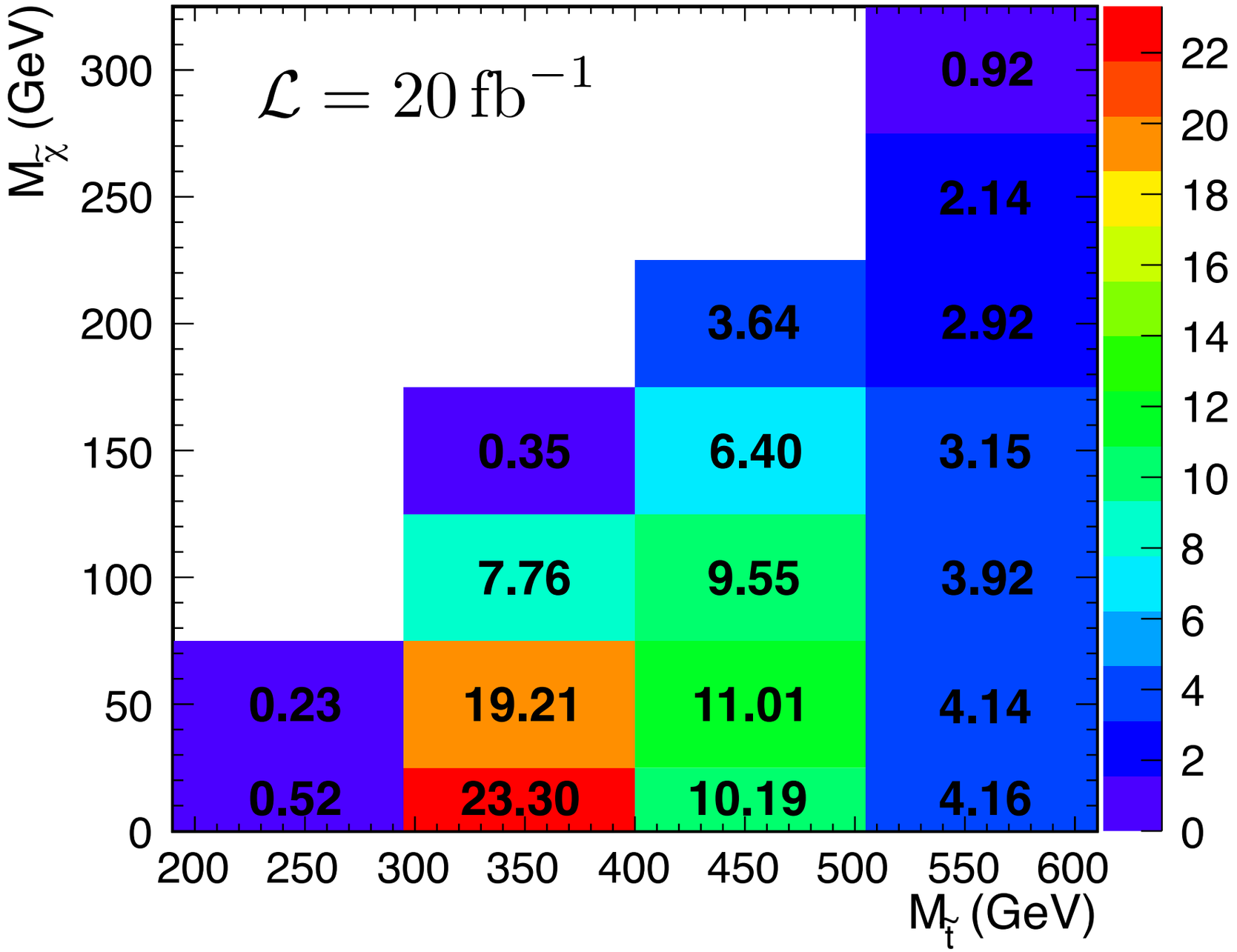
7 TeV RESULTS



8 TeV RESULTS



CONCLUSIONS

- Stops are most important test of naturalness, no direct limit yet
- All hadronic final states are cleaner to search for missing energy
- Top tagging combined with other simple cuts can bring out signal with current data set
- Kinematic cuts can make S/B >> 1, allowing for discovery or exclusion in a large region of parameter space

THANK YOU