Measurement of Jet Multiplicity in Top Quark Pair Events in Dilepton Final States

Introduction and Motivation

Jet multiplicity

Gap Fraction

Conclusions

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HELMHOLTZ | ASSOCIATION

Quick reminder

> At least 2 isolated leptons
  - opposite sign, pT>20 GeV, |eta|<2.4
  - DiLepton Mass > 12 GeV

> At least 2 jets
  - p_T > 30 GeV, |eta| <2.4

> At least 1 b-tag (CSVL)

> Z Veto in ee/mumu

> $E_{T,miss}$ > 30 GeV in ee/mumu

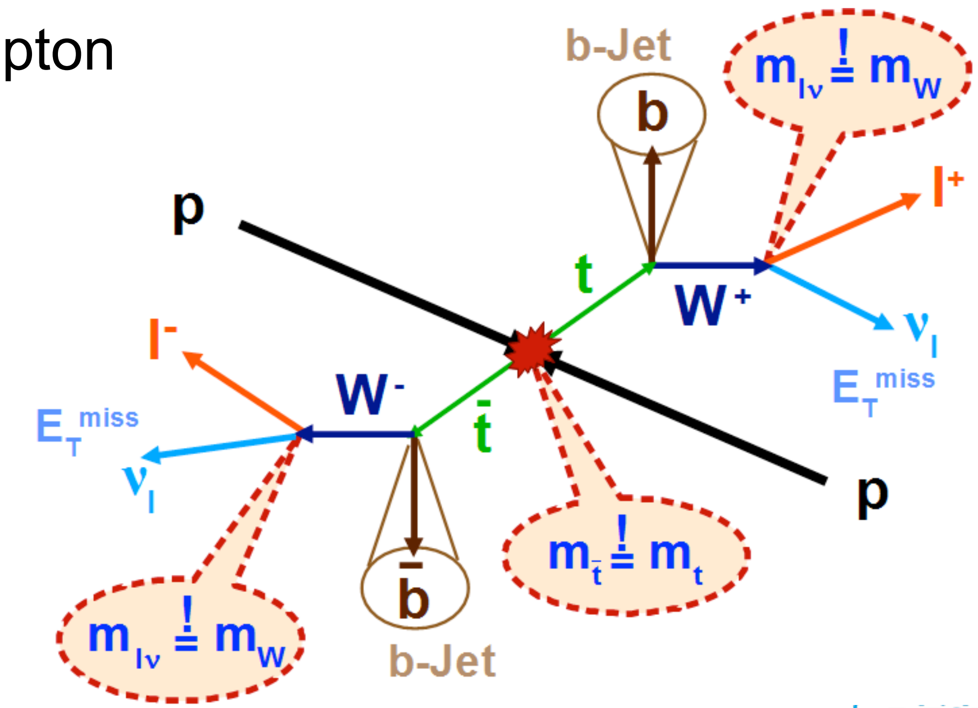
> DY Scale factor from data

Selection and unfolding covered by J. Lange & I. Asin Cruz in the previous presentations

Kinematic Reconstruction

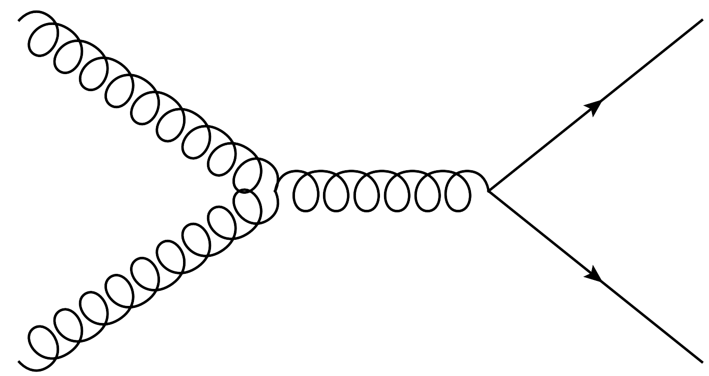
- Under-constrained System (2 neutrinos)
- Constraints:
  - m_W =80.4 GeV
  - m_t = $m_{anti\text{-}t}$=fixed value
  - $p_{\nu 1}(x,y)$ + $p_{\nu 2}(x,y)$ = MET
- vary m_t in 1 GeV steps from 100-300 GeV
- Prefer solutions with multiple b-tags
- Remaining degeneracy broken by match of neutrinos to generated MC spectrum
- 90% efficient (mass window dependent)

Dilepton

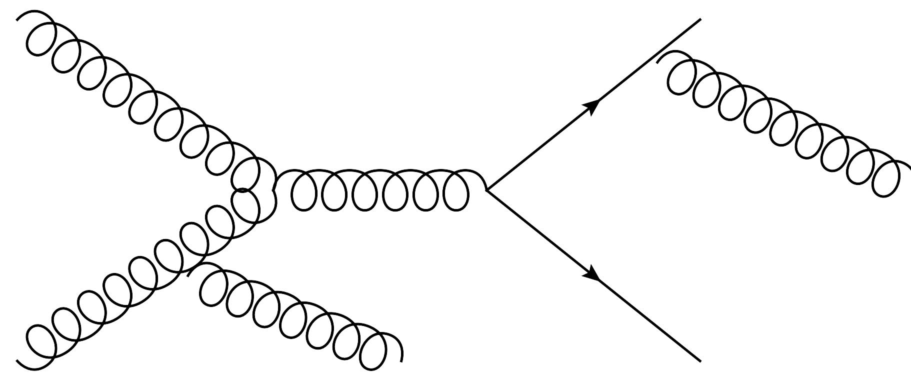


Motivation

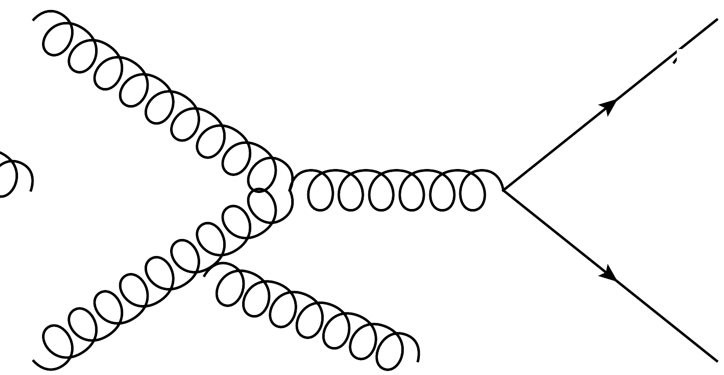
- Many **additional** jets can be produced along with the interesting physics process
- These are determined in MC by parameters in ME+PS
- ISR/FSR modeling via ME from assumed Q^2
- Matching procedure to remove double counting between ME and PS
- NLO generators have less uncertainty on Q^2



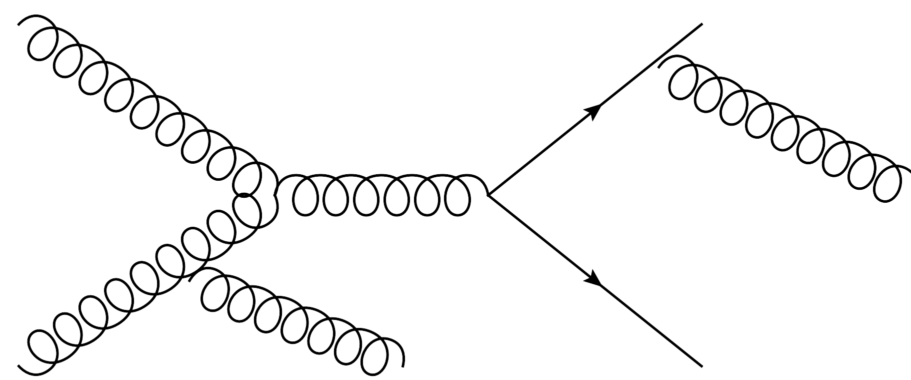
Matrix Element + PS (MadGraph)

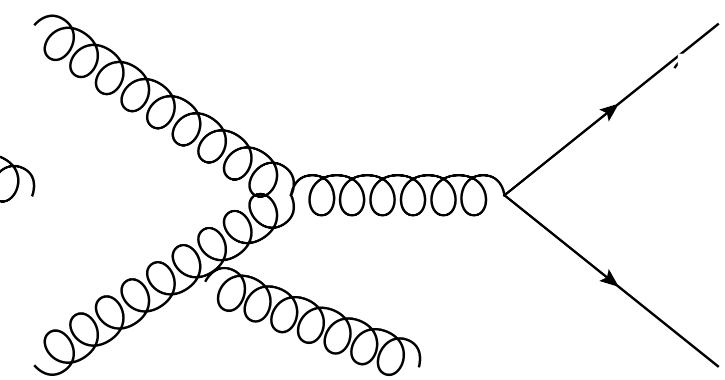


$Q^2/4$ Scale
Matching Down



$4*Q^2$ Scale
Matching Up

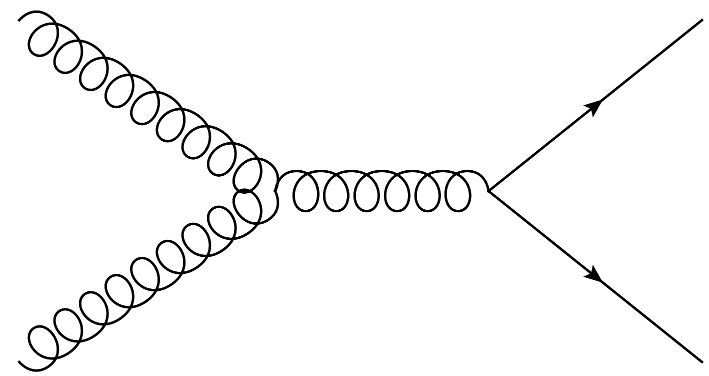




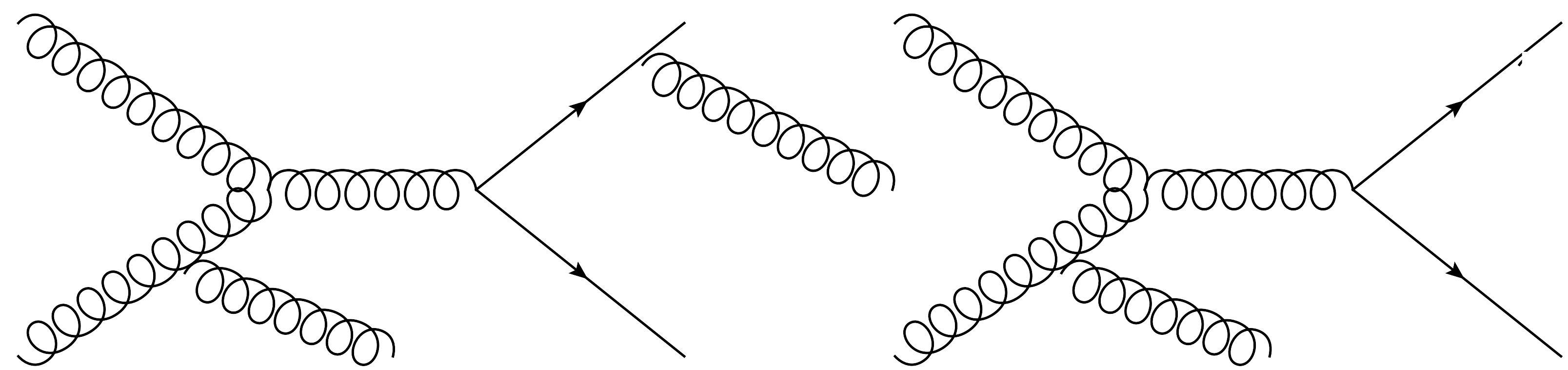
MC@NLO + Herwig
POWHEG + Pythis

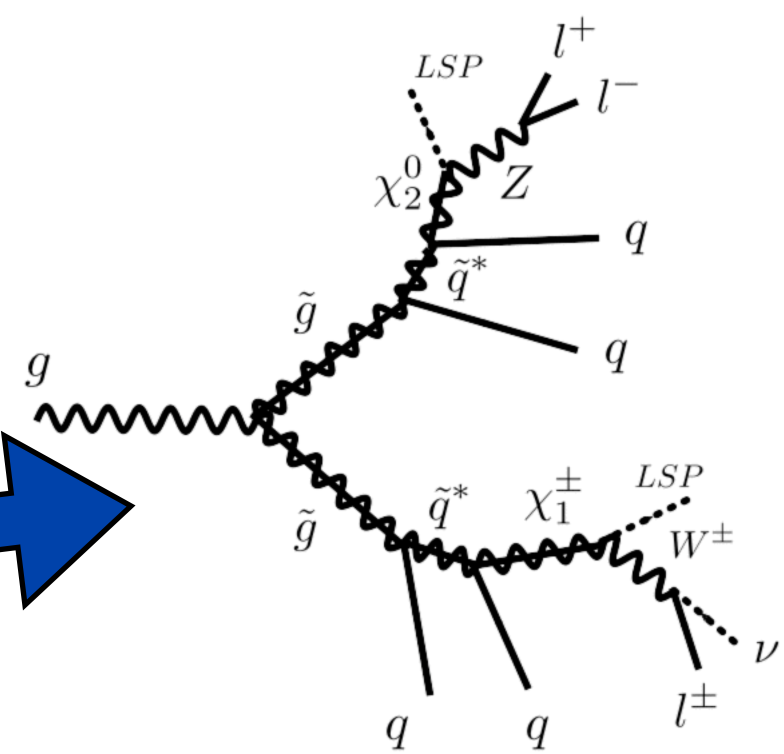
Motivation

- Many **additional** jets can be produced along with the interesting physics process
- These are determined in MC by parameters in ME+PS
- ISR/FSR modeling via ME from assumed Q^2
- Matching procedure to remove double counting between ME and PS
- NLO generators have less uncertainty on Q^2
- The better we understand the these effects more we can constrain our systematics...
- And better search for things like this



Matrix Element + PS (MadGraph)





Control Distributions

- **Very Good** agreement between model and measurement observed
- Very pure ttbar sample
- MadGraph used for the nominal sample

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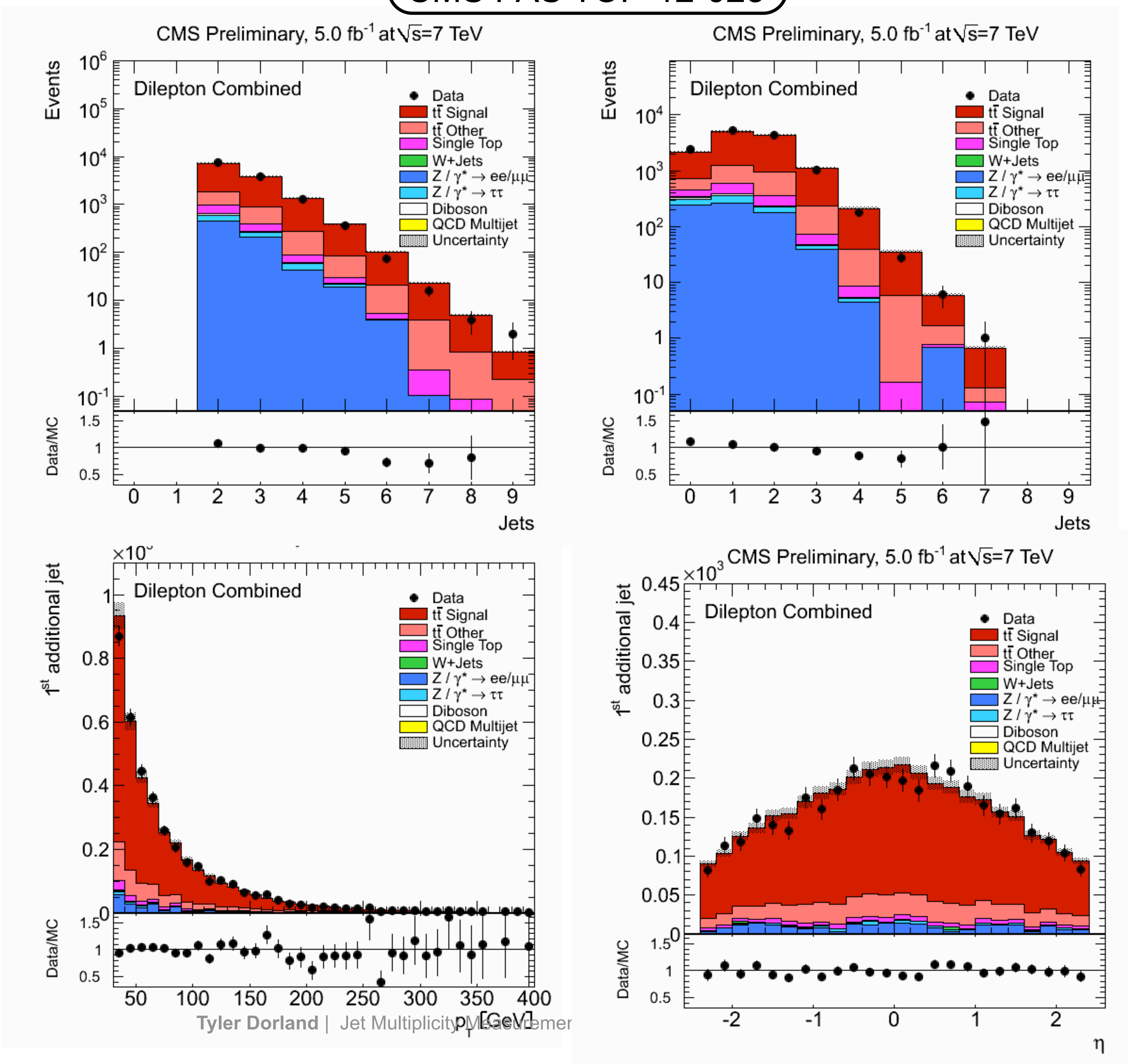

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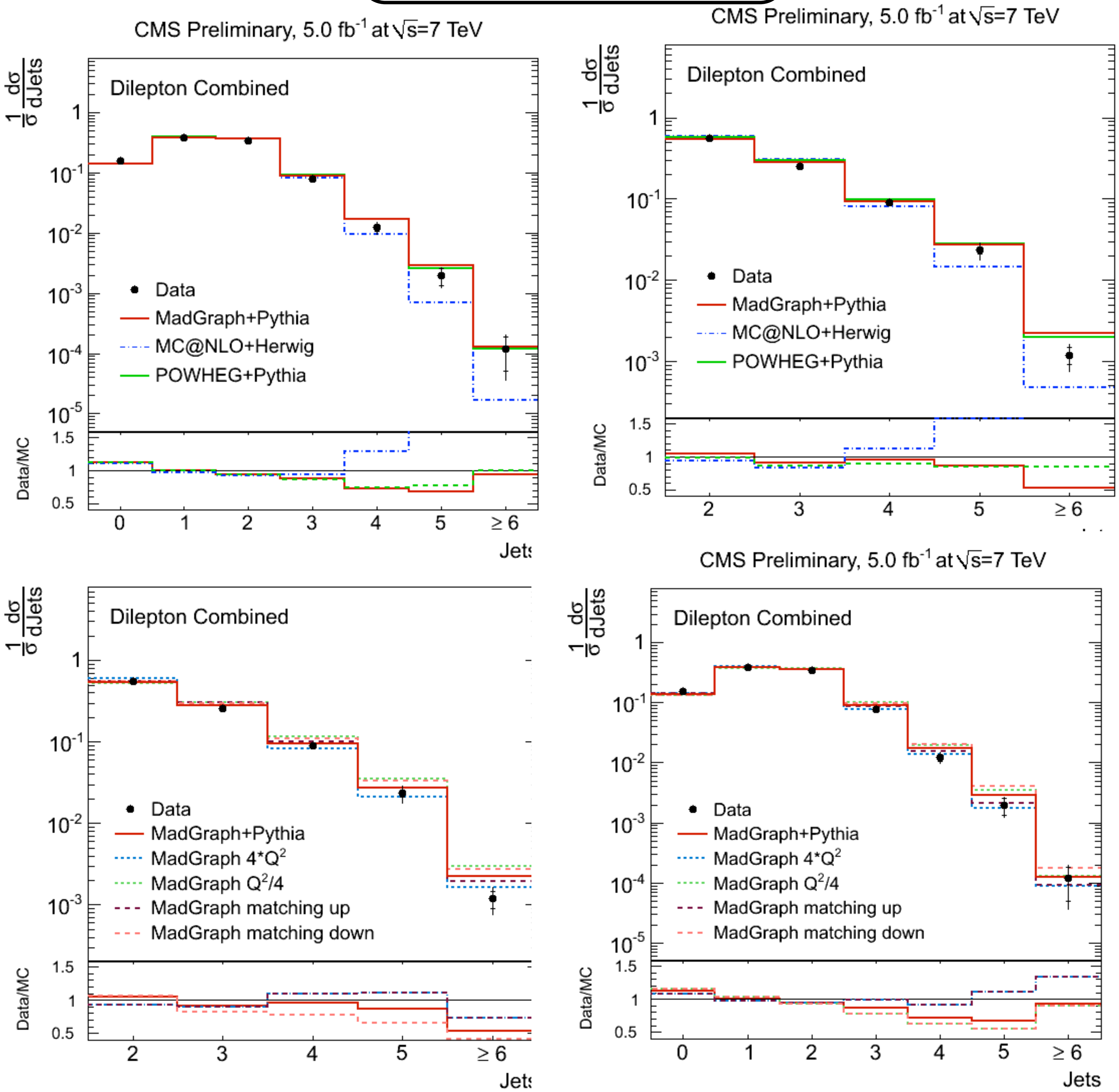
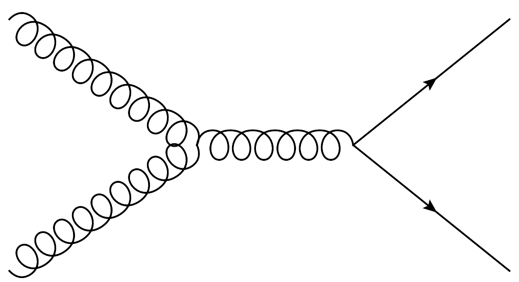
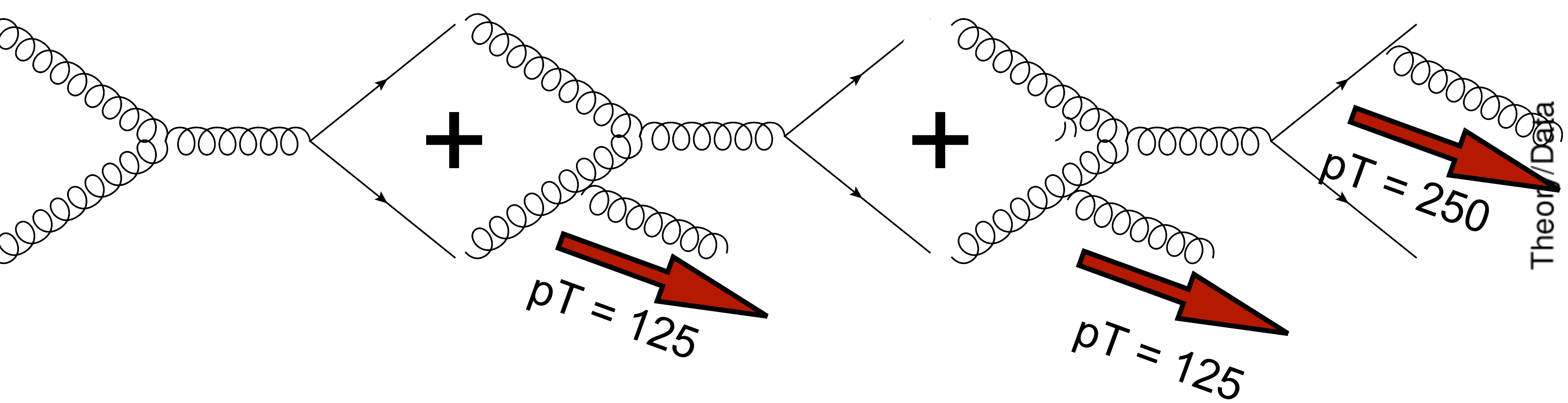
- All distributions unfolded to account for detector effects
- Measurement made in the visible phase space and extrapolated to full phase space
- Comparison made to
  - MC@NLO+Herwig
  - POWHEG+Pythia
- Matching/Scale parameters varied
- **No evidence** for a better description of data by one generator

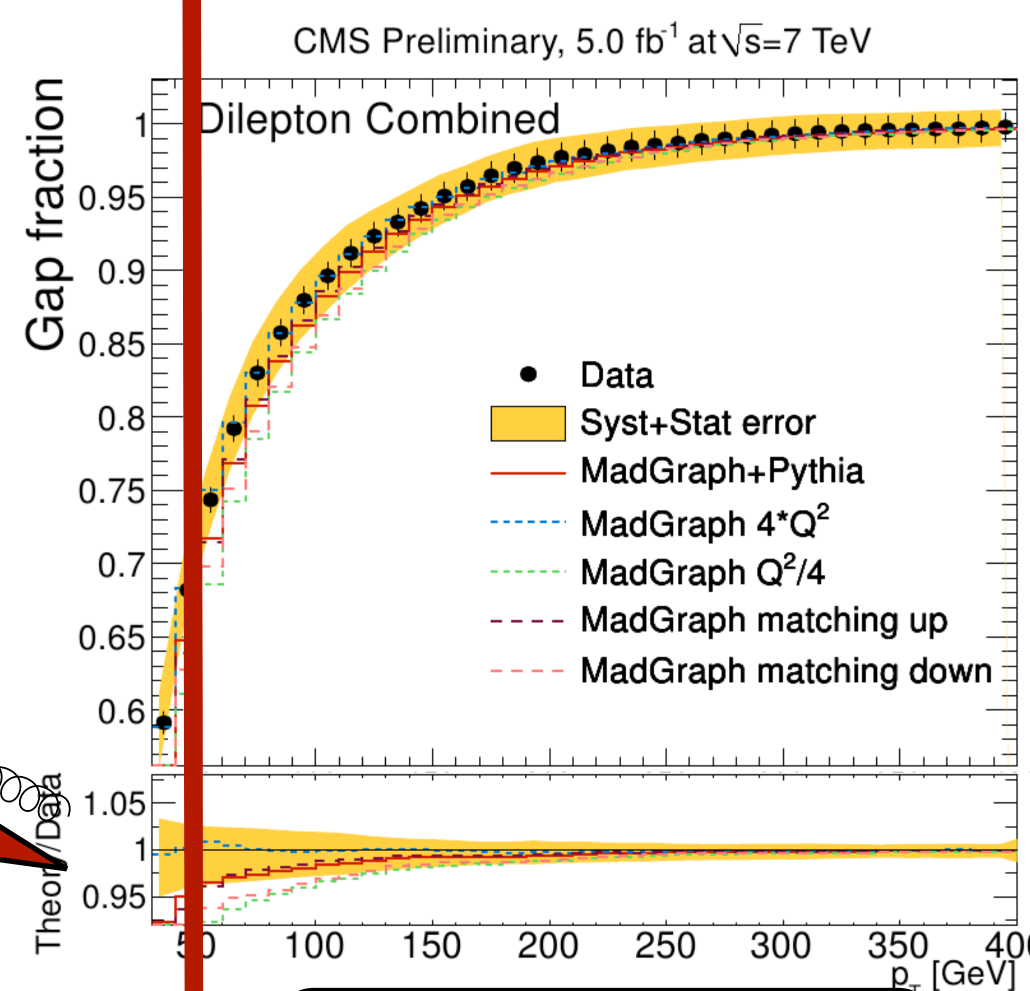


What is a gap fraction

- Alternative measurement of jet activity arising from quark or gluon
- Additional jet is defined as a jet not used in tt reconstruction
- Gap fraction is number of events with **NO** additional jet above a given threshold $f(p_T) = \frac{N(no\ add.\ jet > p_T)}{N_{total}}$ $\quad f(H_T) = \frac{N(no\ add.\ jet > H_T)}{N_{total}}$







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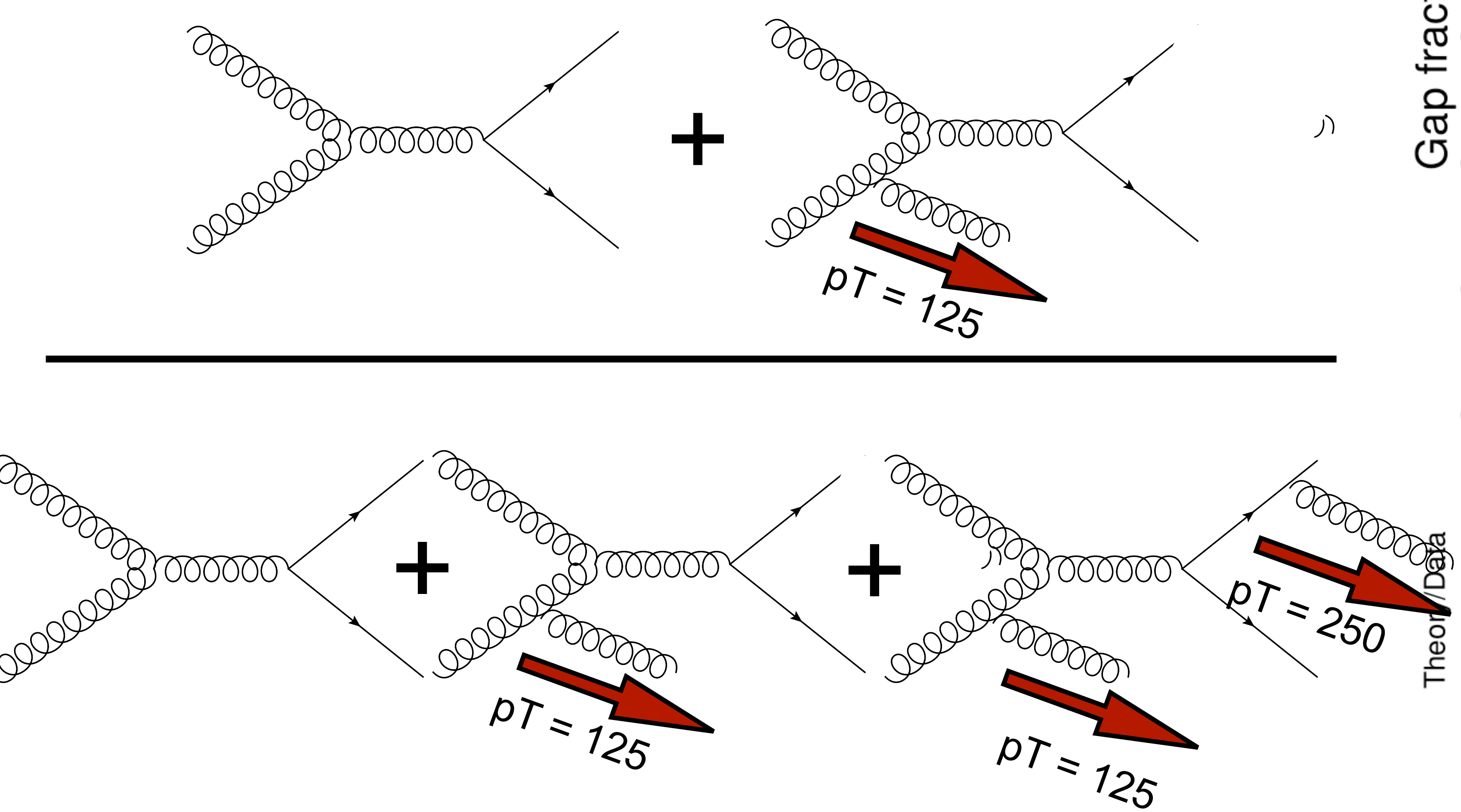
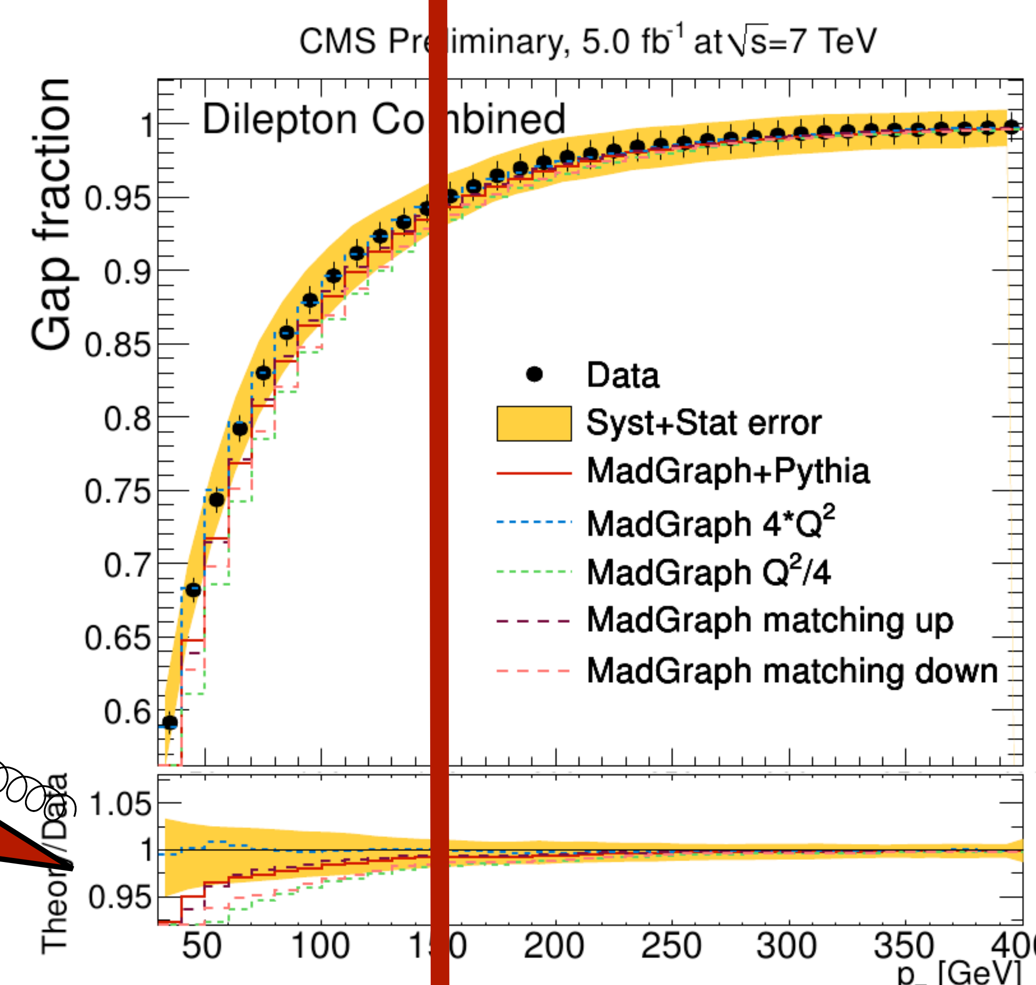
pT threshold = 50

What is a gap fraction

- Alternative measurement of jet activity arising from quark or gluon
- Additional jet is defined as a jet not used in tt reconstruction
- Gap fraction is number of events with **NO** additional jet above a given threshold $f(p_T) = \frac{N(no\ add.\ jet > p_T)}{N_{total}}$ $f(H_T) = \frac{N(no\ add.\ jet > H_T)}{N_{total}}$





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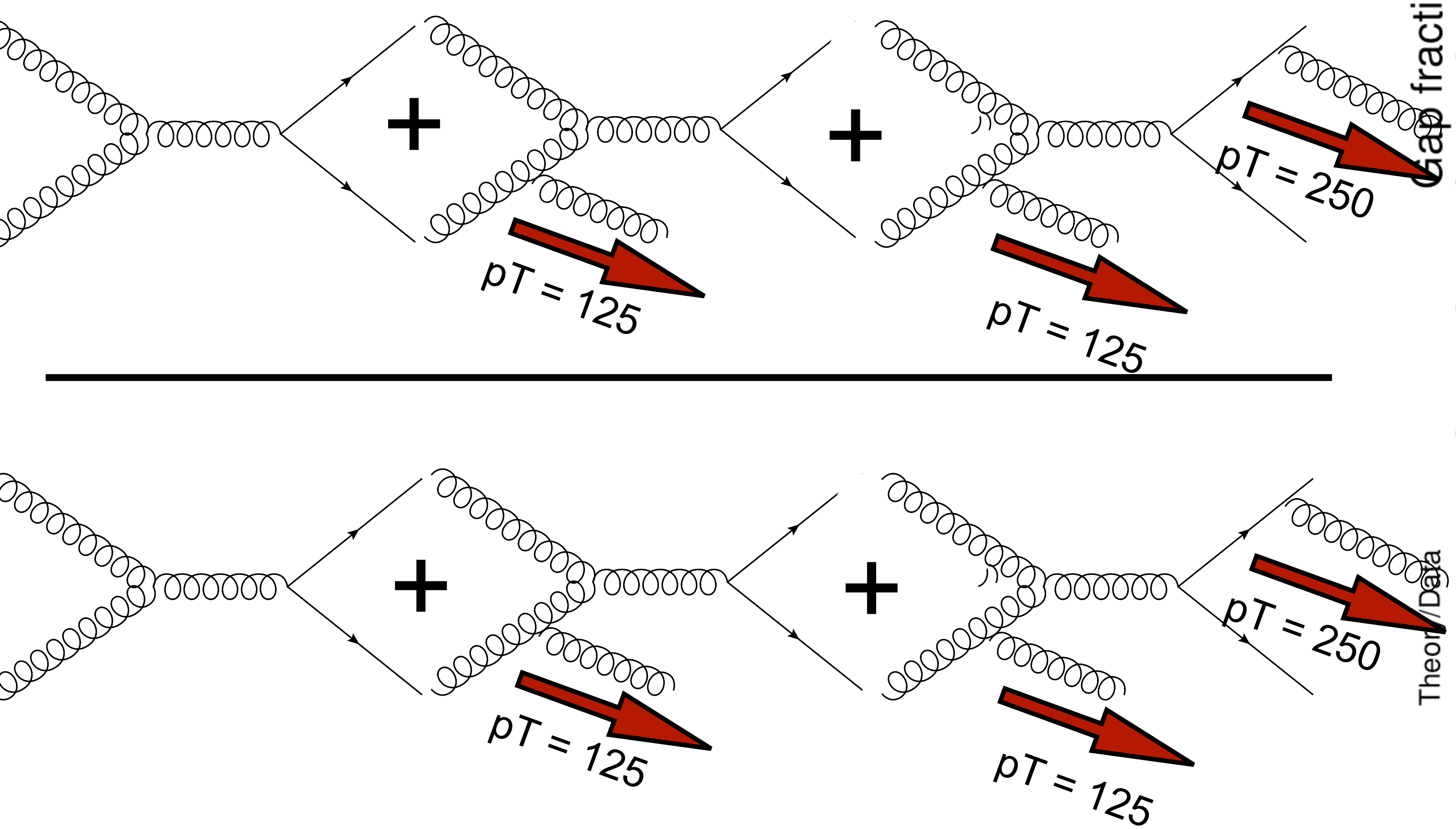
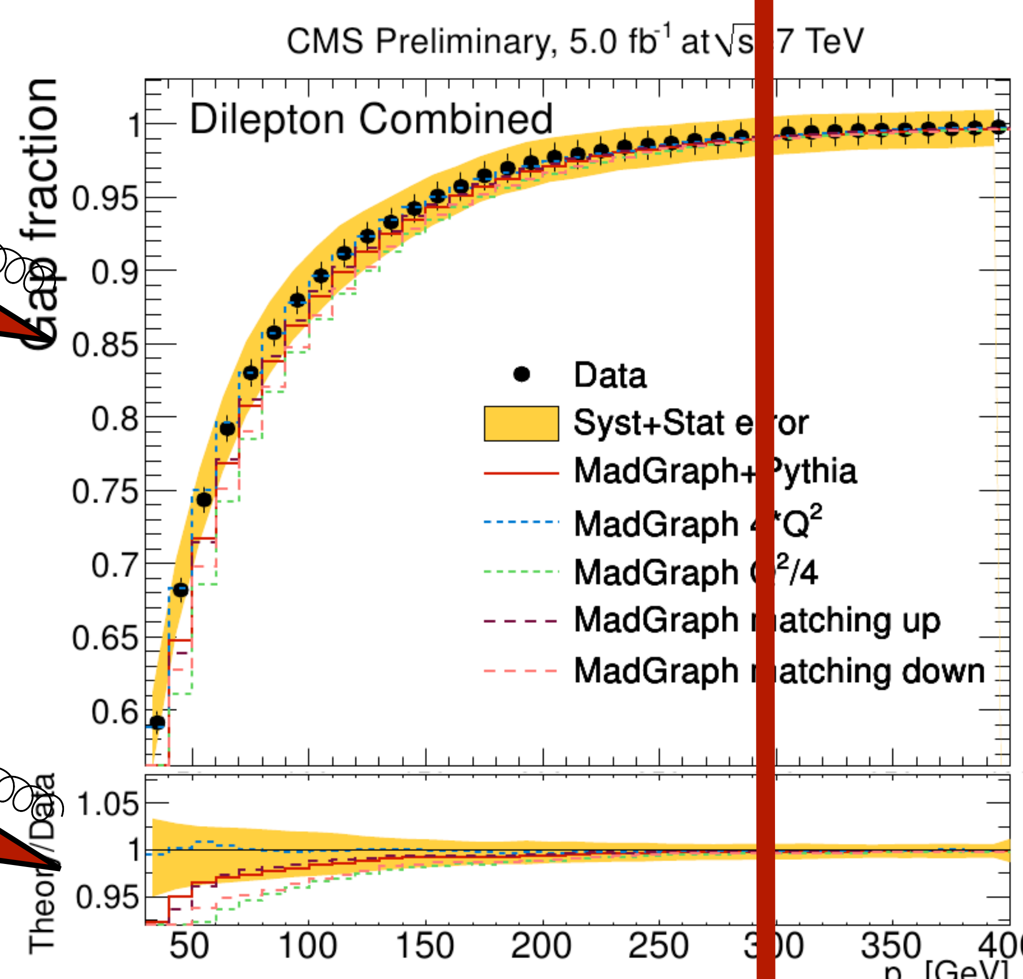
pT threshold = 150

What is a gap fraction

- Alternative measurement of jet activity arising from quark or gluon
- Additional jet is defined as a jet not used in tt reconstruction
- Gap fraction is number of events with **NO** additional jet above a given threshold

$$f(p_T) = \frac{N(no\ add.\ jet > p_T)}{N_{total}} \qquad f(H_T) = \frac{N(no\ add.\ jet > H_T)}{N_{total}}$$





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pT threshold = 300

Results of the gap fraction measurement

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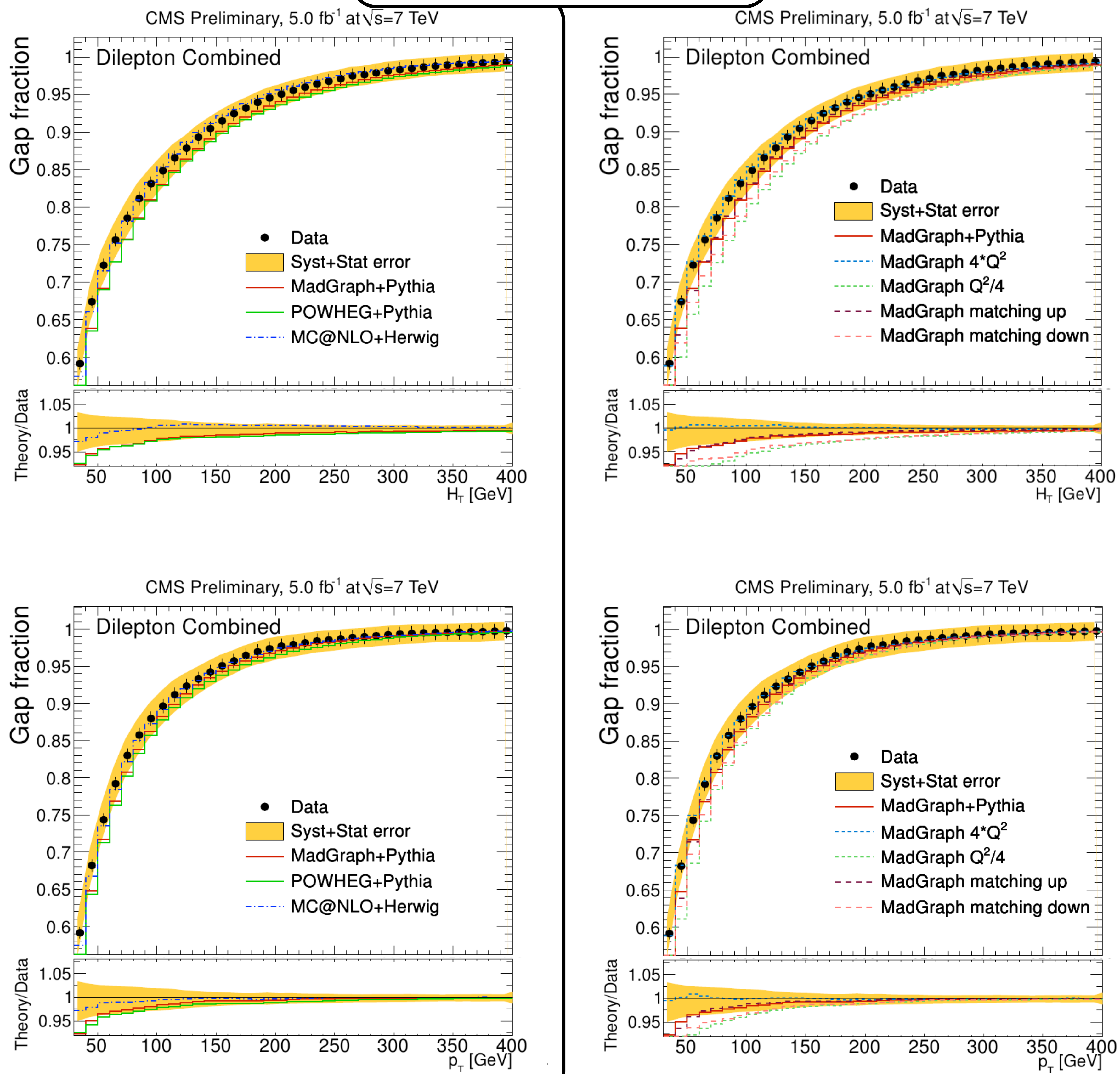
- In General a very good agreement again between model and data
- Comparing different generators gives a slight preference to MC@NLO +Herwig



Results of the gap fraction measurement

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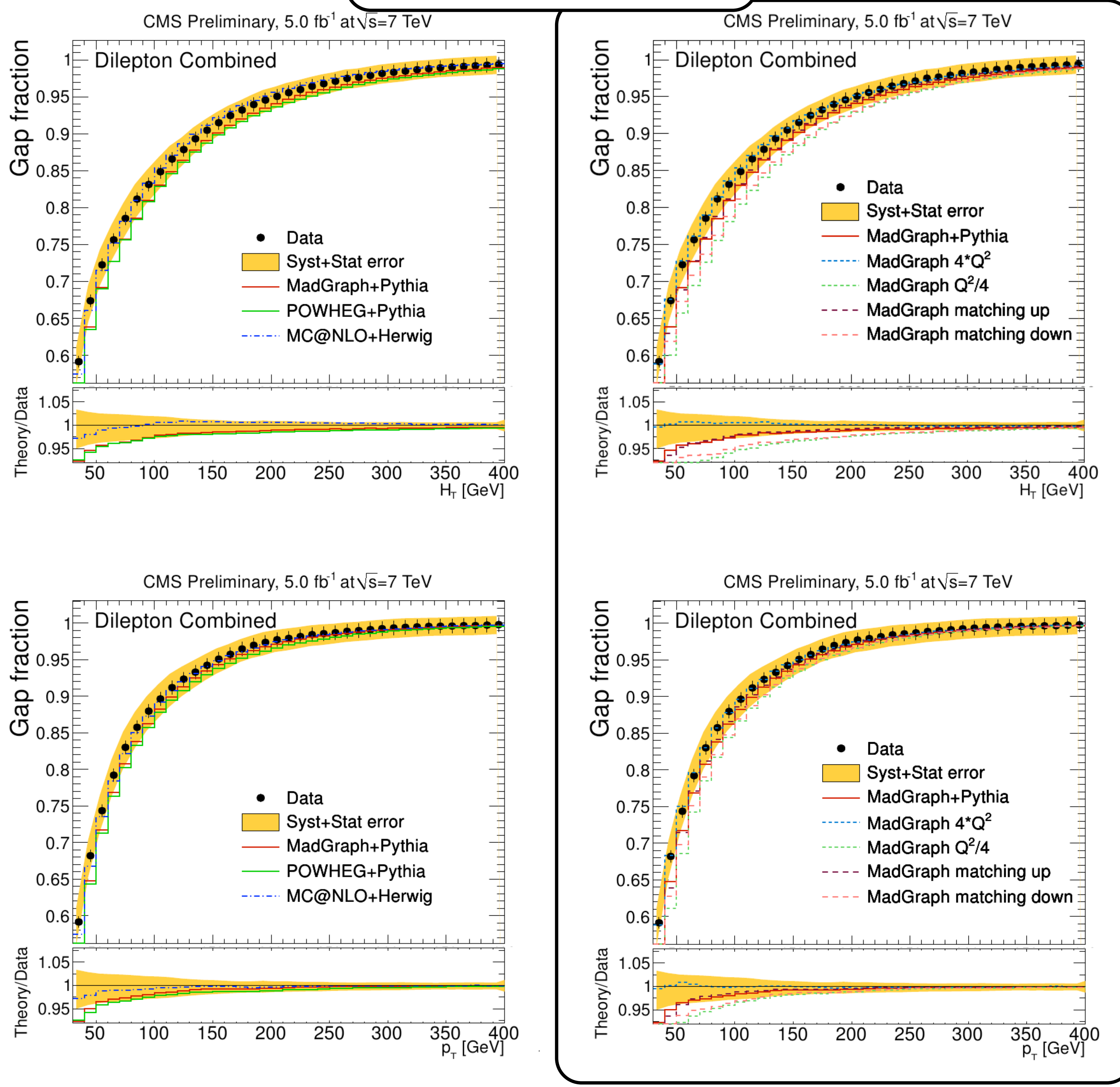
- In General a very good agreement again between model and data
- Comparing different generators gives a slight preference to MC@NLO +Herwig
- Comparing different MadGraph scales:
  - Data better described by higher Q^2
- Variations seem to be much larger than experimental precision
  - variations can be **reduced**



Results of the gap fraction measurement

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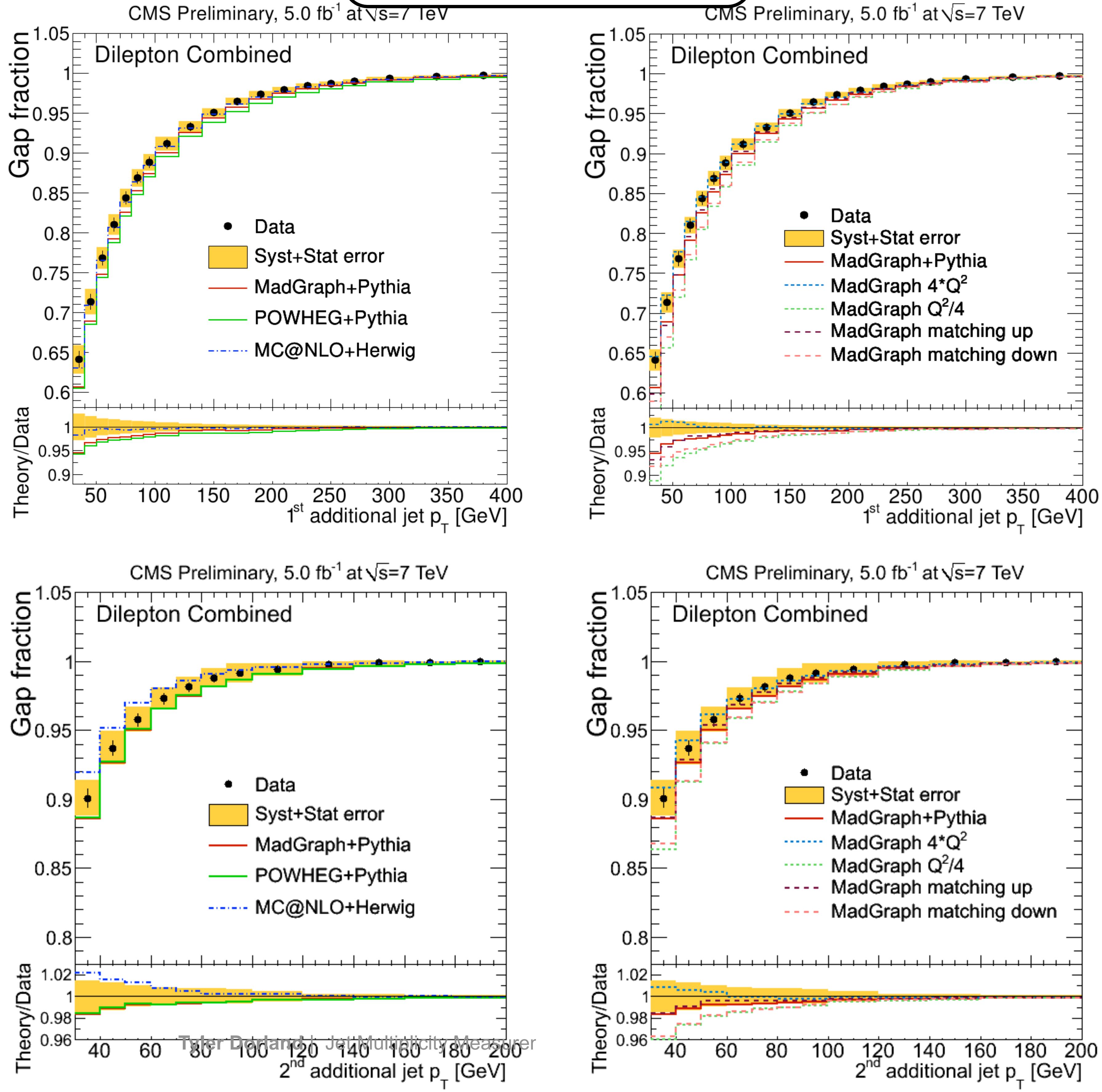
- MC@NLO+Herwig modeling the the 2nd additional jet much differently
  - Difference between Pythia and Herwig?
- Higher scale variations seem to model data better in these distributions as well
  - but overall the variations are again larger than experimental uncertainty



Conclusions

- Measurement of differential jet multiplicity and Gap fraction performed in the dilepton channel
- Data is well described by the current Monte Carlo
- No immediate evidence to exclude any MC generator
- Gap fractions can be used to help with systematic variations
  - With the goal of reducing the overall systematic uncertainty