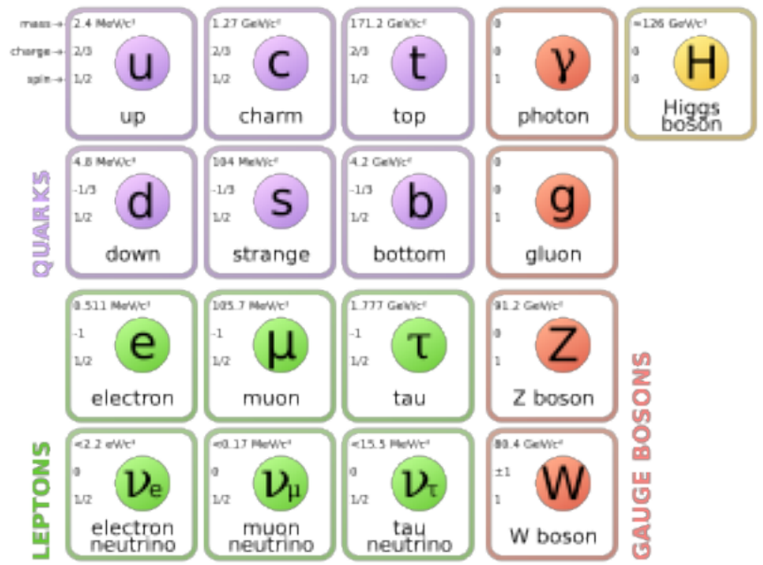
Measurement of the Top-Quark-Pair Differential Cross-Section at 8 TeV

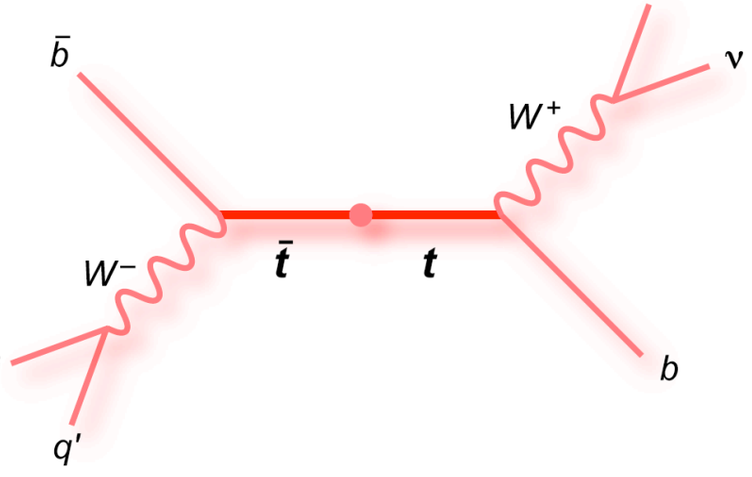
November 8th, 2013
Tyler Dorland
DESY

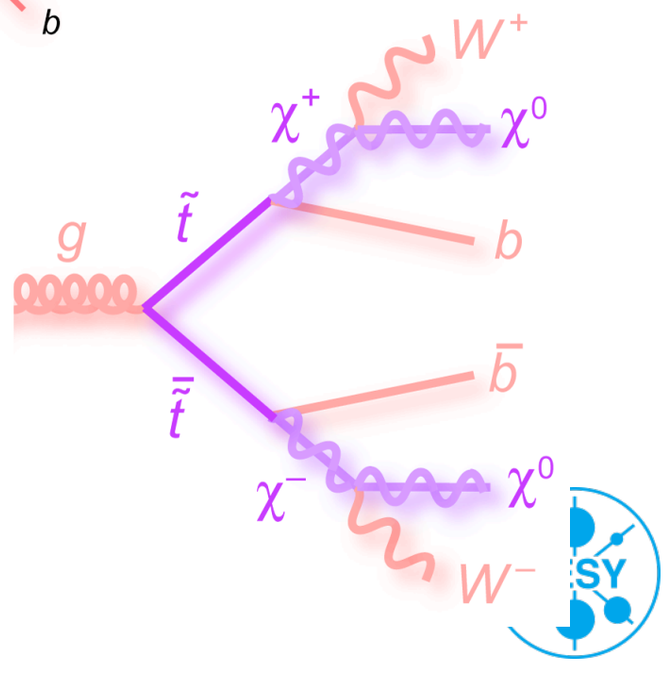
HELMHOLTZ ASSOCIATION

Motivation

- Unique properties of the top quark allow for measurements of fundamental quark properties
- We now have a complete standard model, but not a fully explored standard model
- Recent measurements have shown possible deviations from QCD at NLO+PS
- Measurements from the LHC wit the full 7 and 8 TeV datasets are the most precise to date, provide valuable information on physics in the top sector



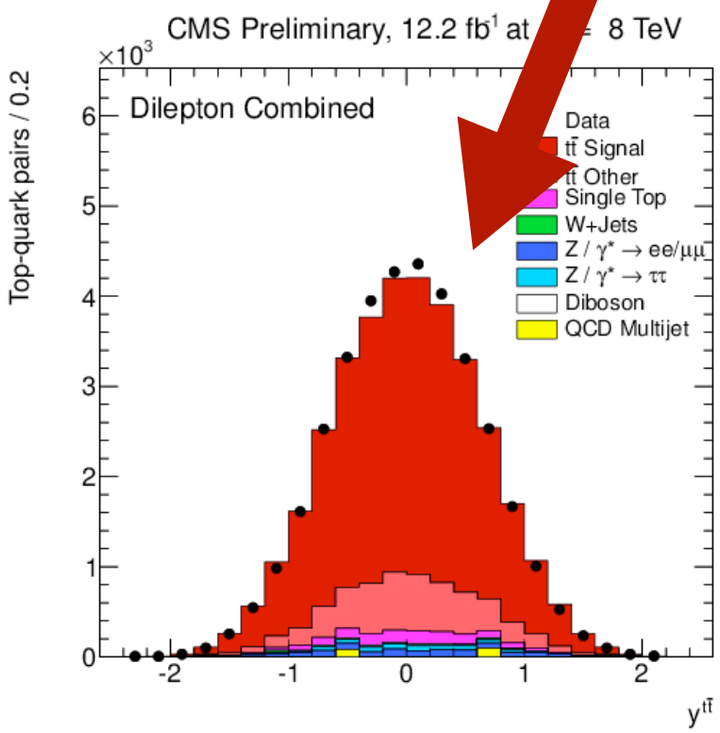




Event selection and Reconstruction

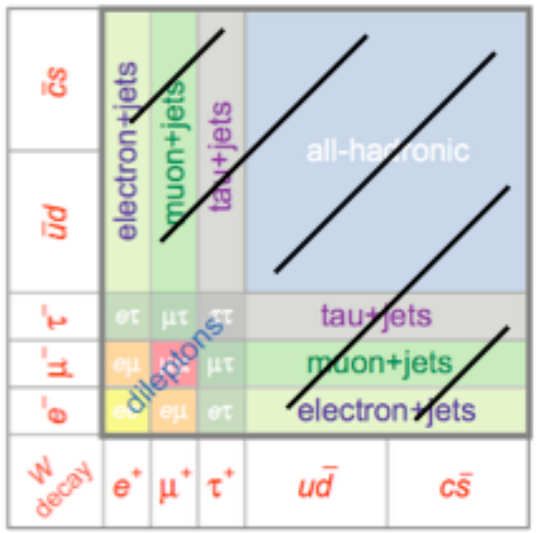
- At least 2 isolated leptons
- At least 2 jets
- At least 2 b-tagged jets
- Z Veto in ee/mumu $76<m_{ll}<106$
- $E_{T,miss}$ > 40 GeV in ee/mumu

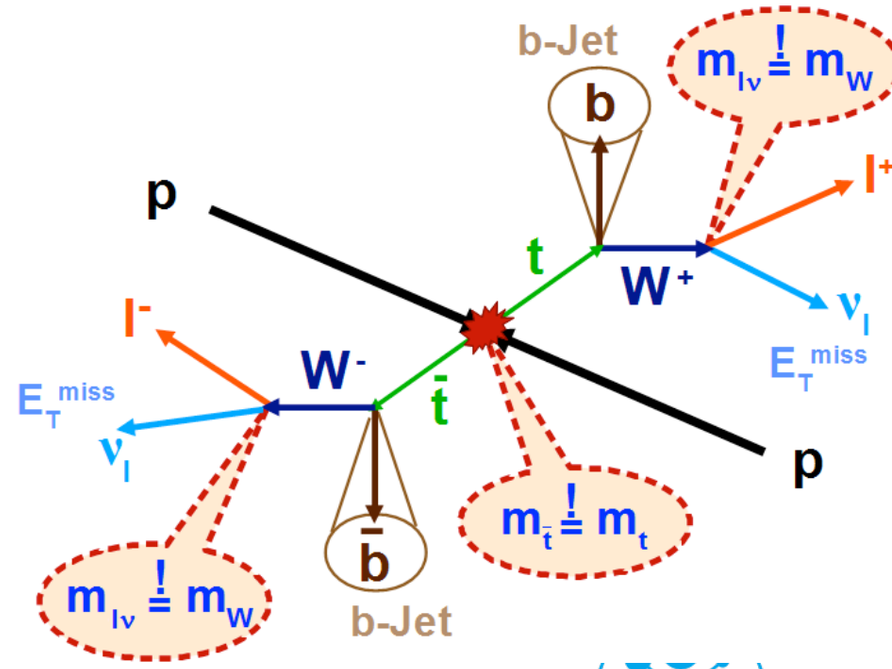
Standard selection cuts give ~90% top-quark-pair sample!!



Kinematic Reconstruction

- Under-constrained System (2 neutrinos)
- Constraints:
  - m_W =80.4 GeV
  - m_t = $m_{anti\text{-}t}$=fixed value
  - $p_{v1}(x,y) + p_{v2}(x,y)$ = 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



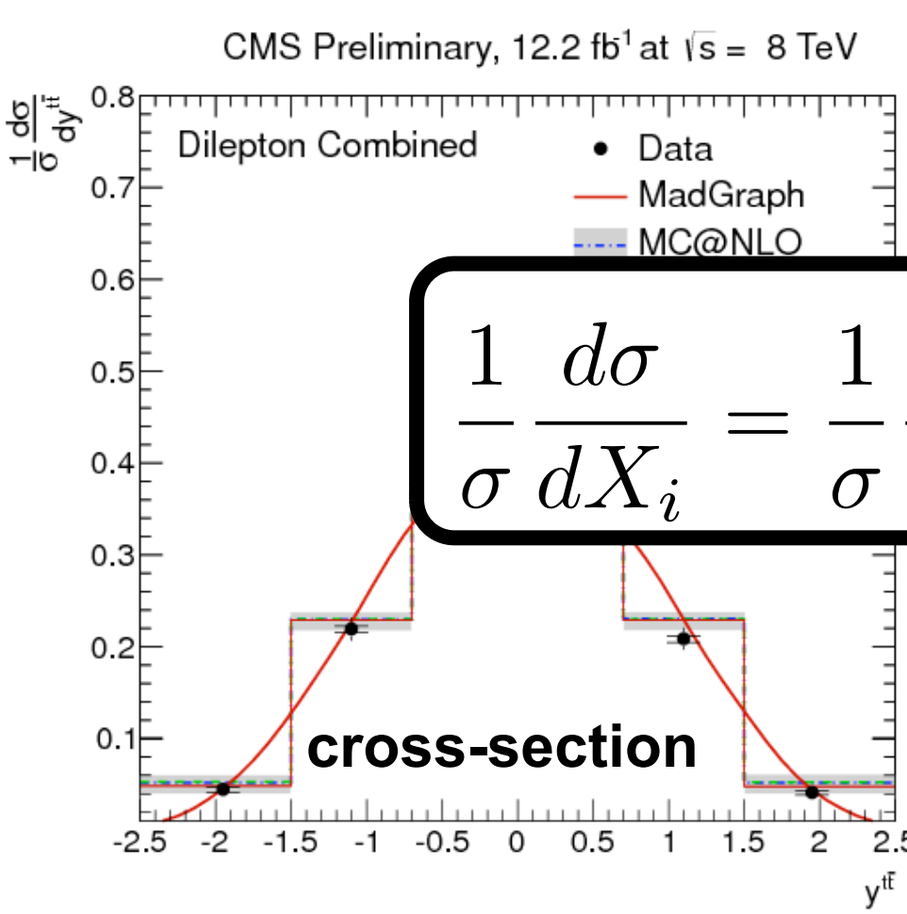


Unfolding

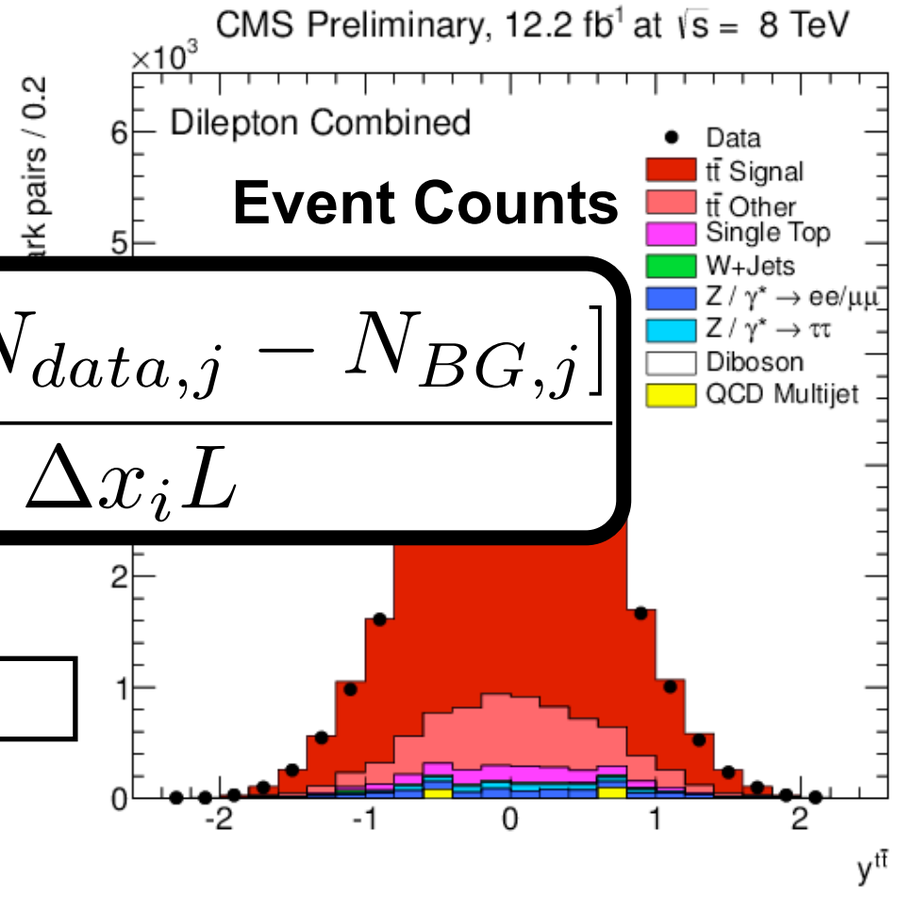
- We perform a regularized unfolding (determined by minimizing the global correlation)
- Correcting for finite detector resolution
- Binning is determined to balance **purity** and **stability**

$$Stability^i = \frac{N^i_{rec\&gen}}{N^i_{gen}}$$

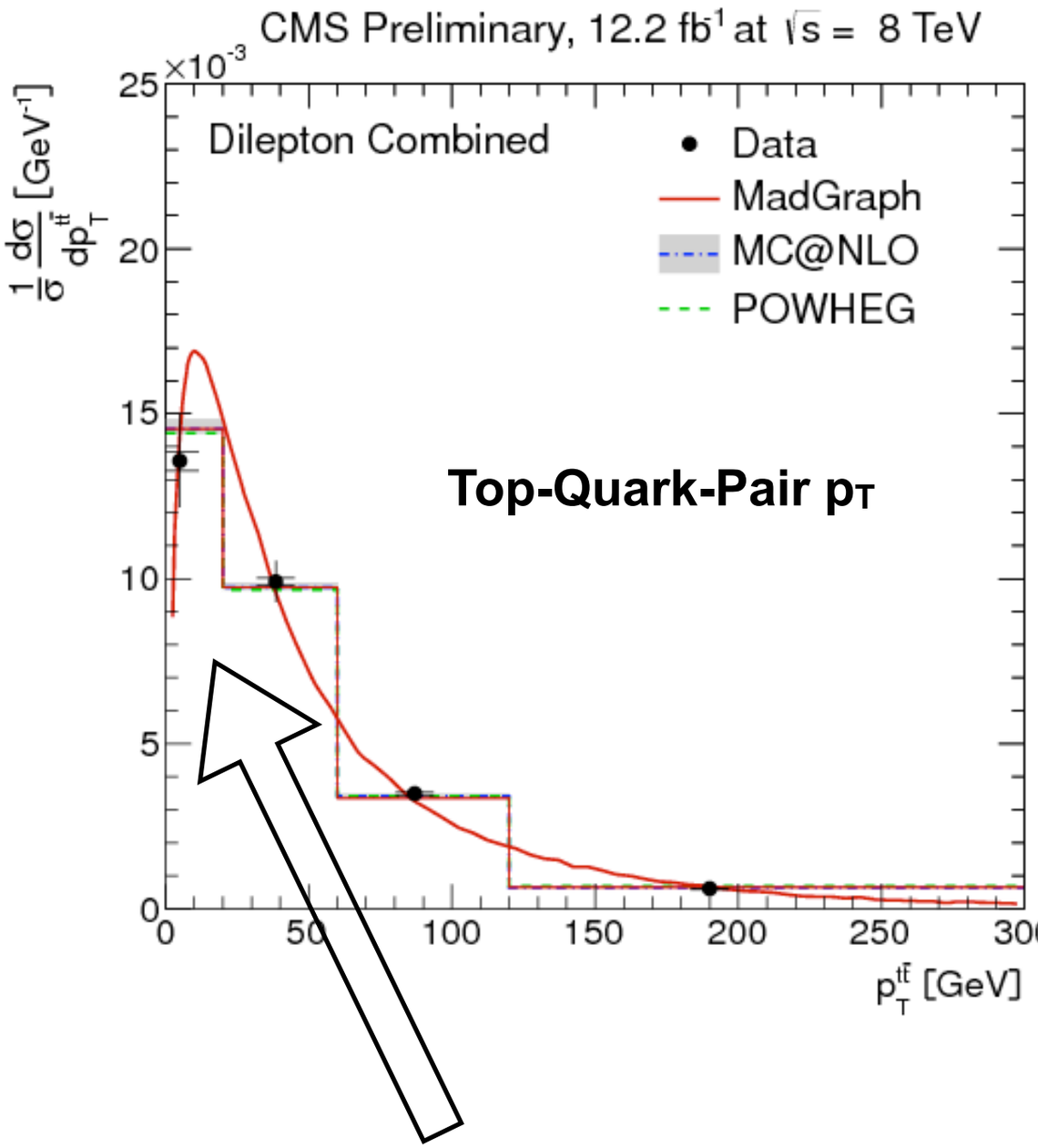
$$Purity^i = \frac{N^i_{rec\&gen}}{N^i_{rec}}$$



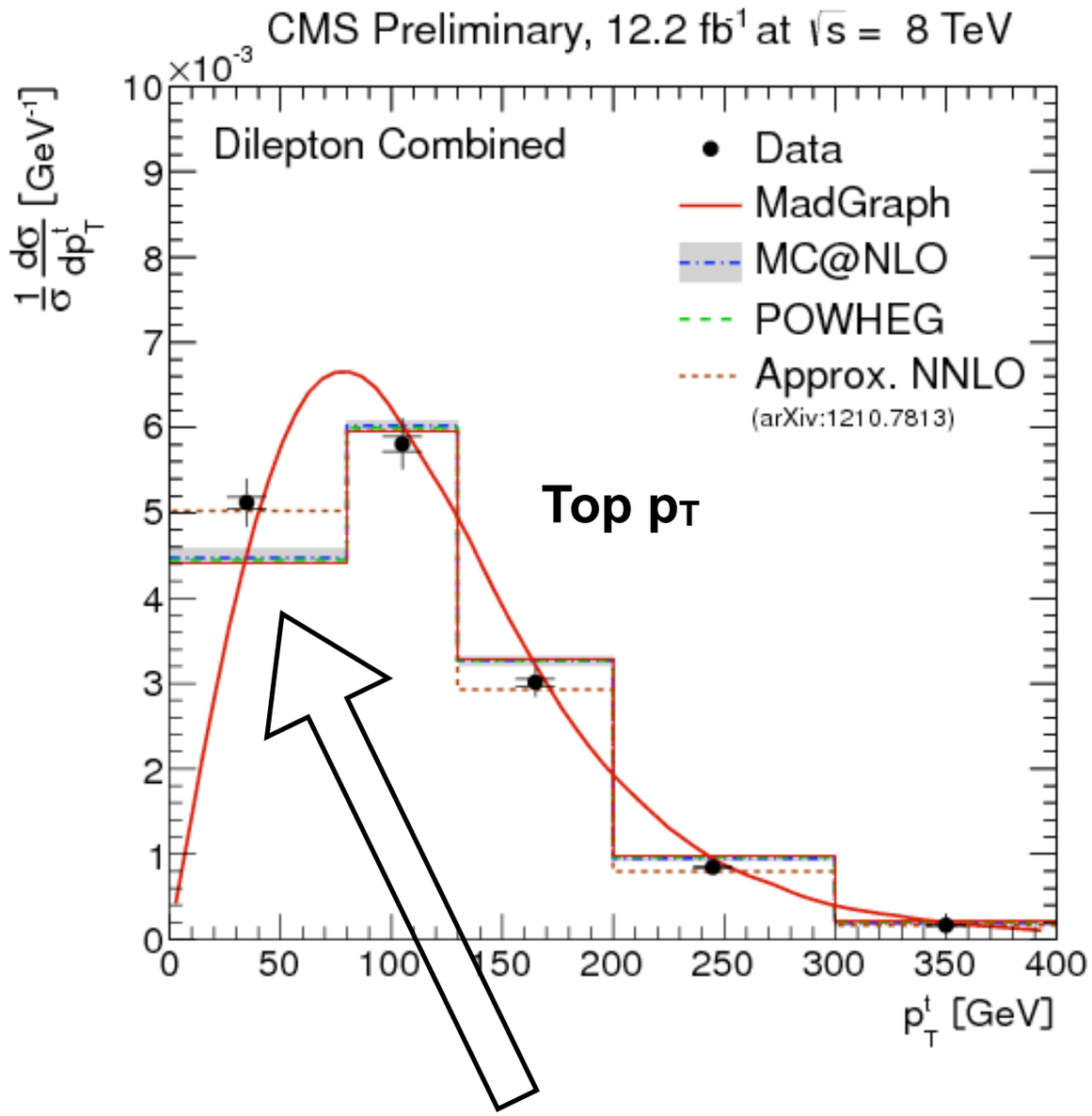
$$\frac{1}{\sigma}\frac{d\sigma}{dX_i} = \frac{1}{\sigma}\frac{\Sigma_j A^{-1}_{ij}\left[N_{data,j} - N_{BG,j}\right]}{\Delta x_i L}$$



Results

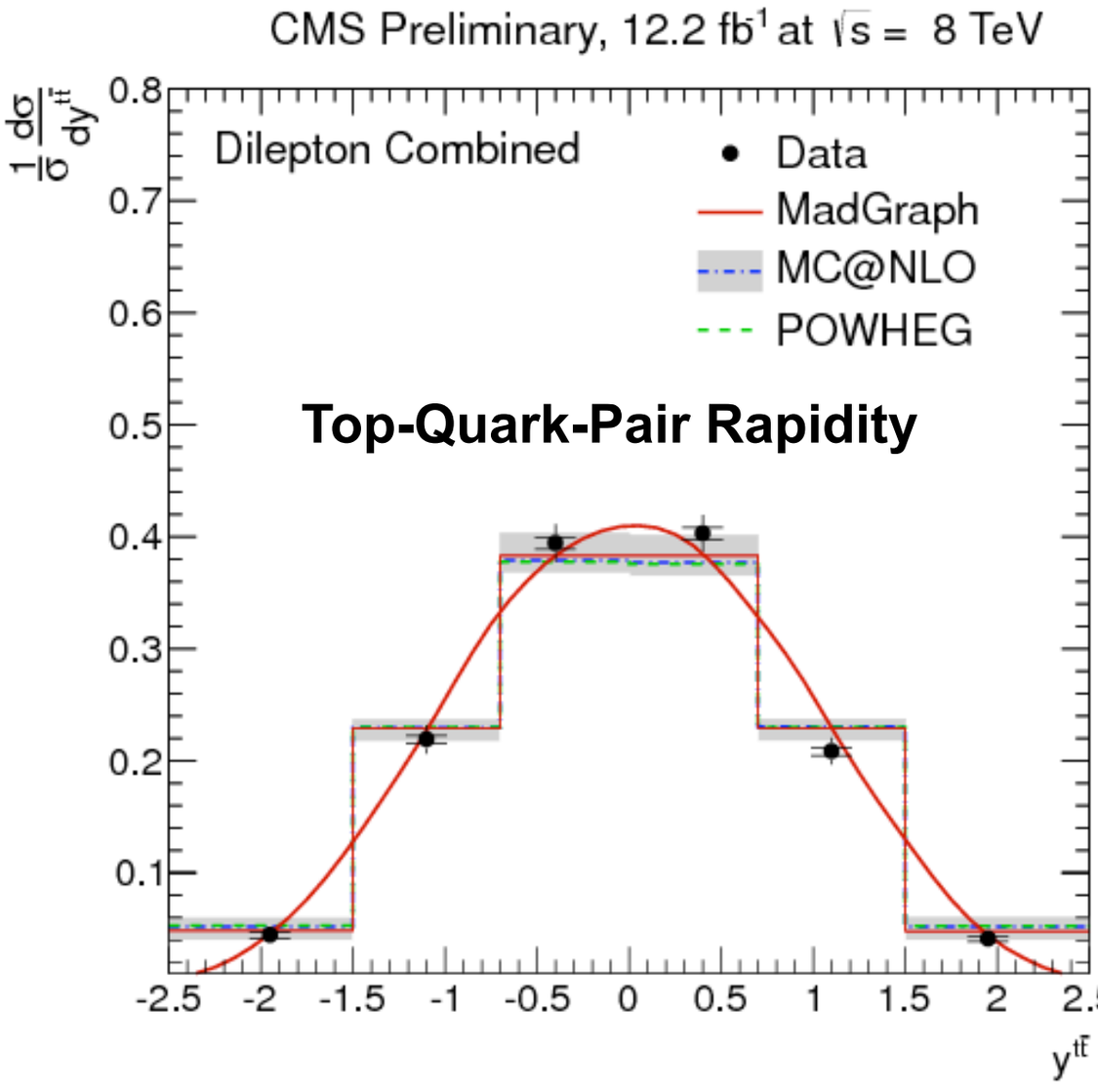


Sensitive to initial and final state radiation

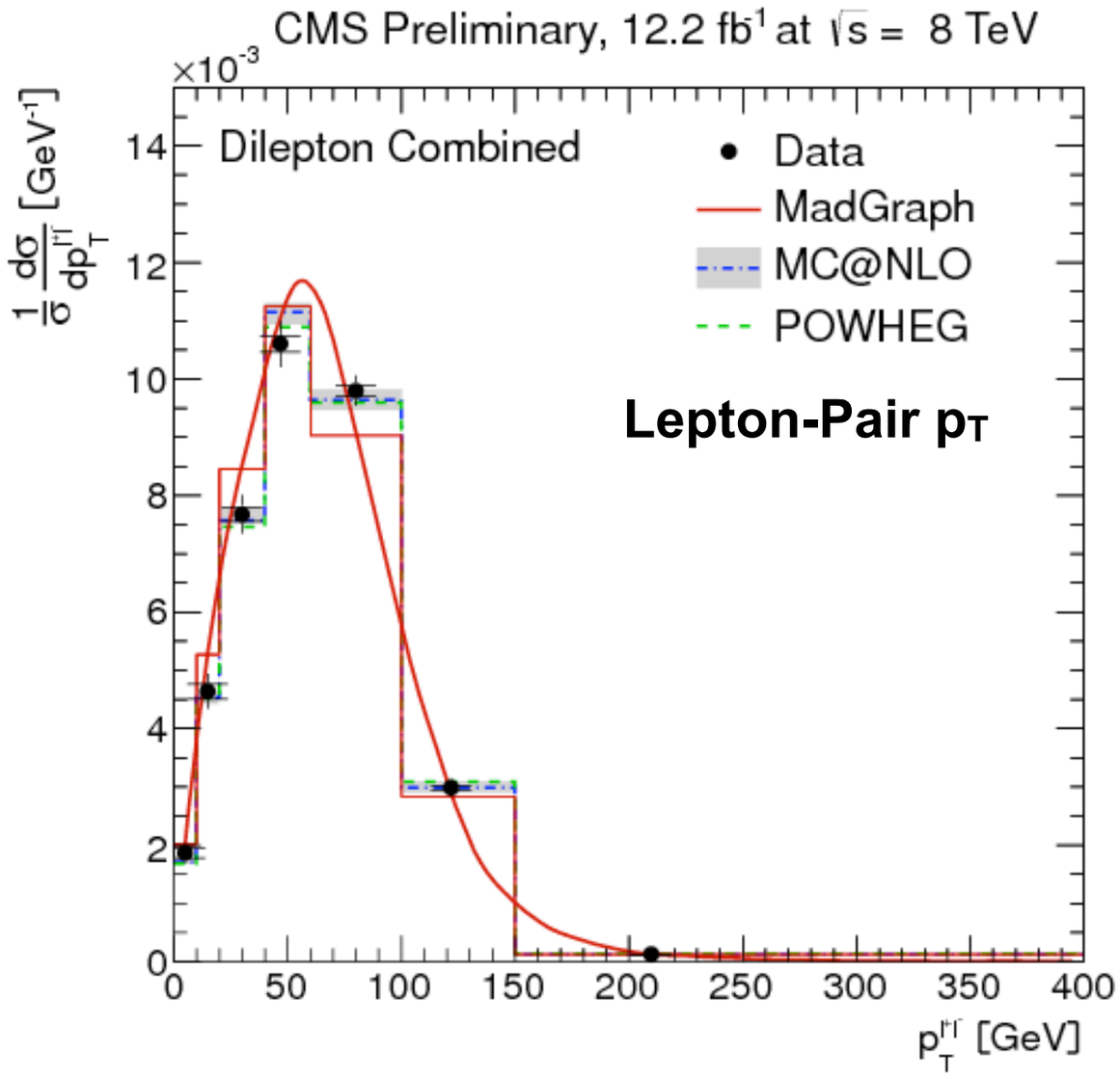


Softer spectrum seen in data than in MC@NLO,POWHEG and MadGraph, Approximate NNLO ok

Results

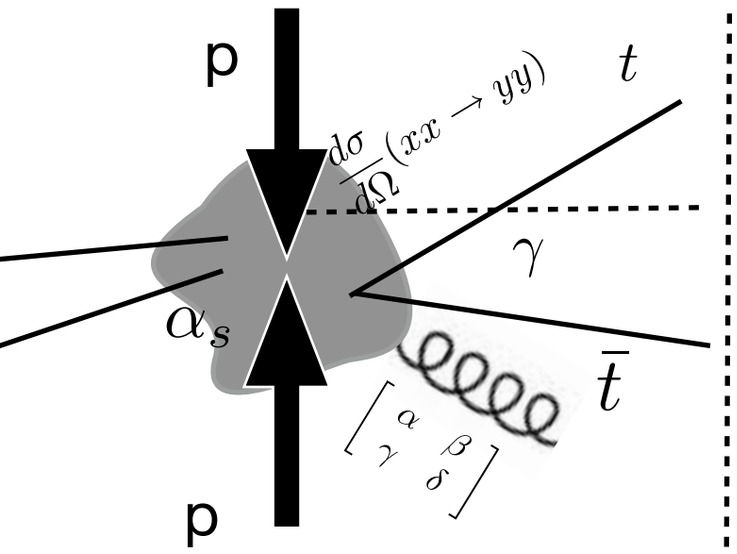


Angular predictions are well modeled by the MC

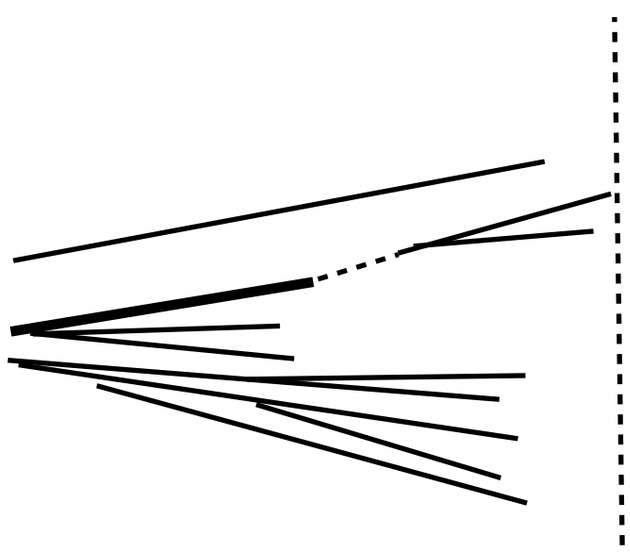


Spin-correlated samples describe cross-section as a function lepton pair better

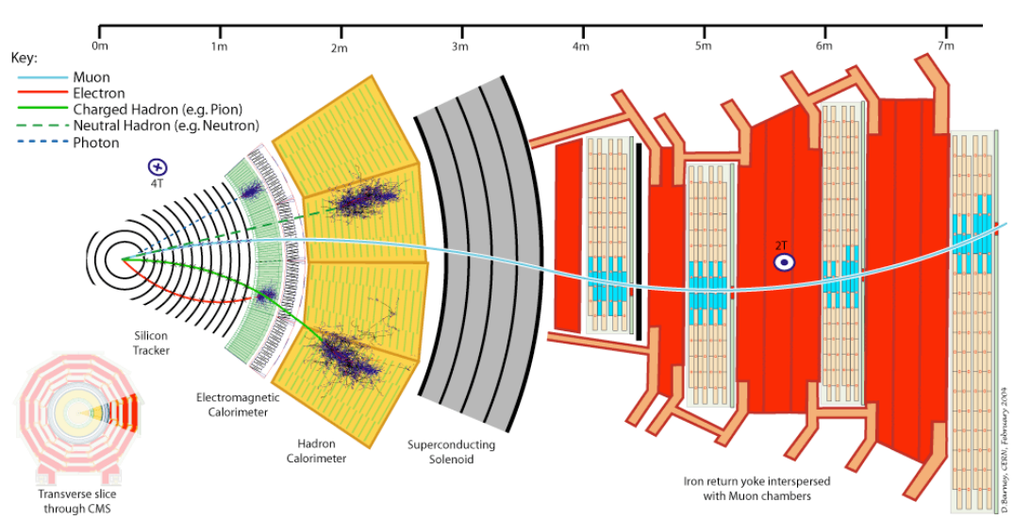
Particle Level Top Definition



parton



particle



Reconstructed

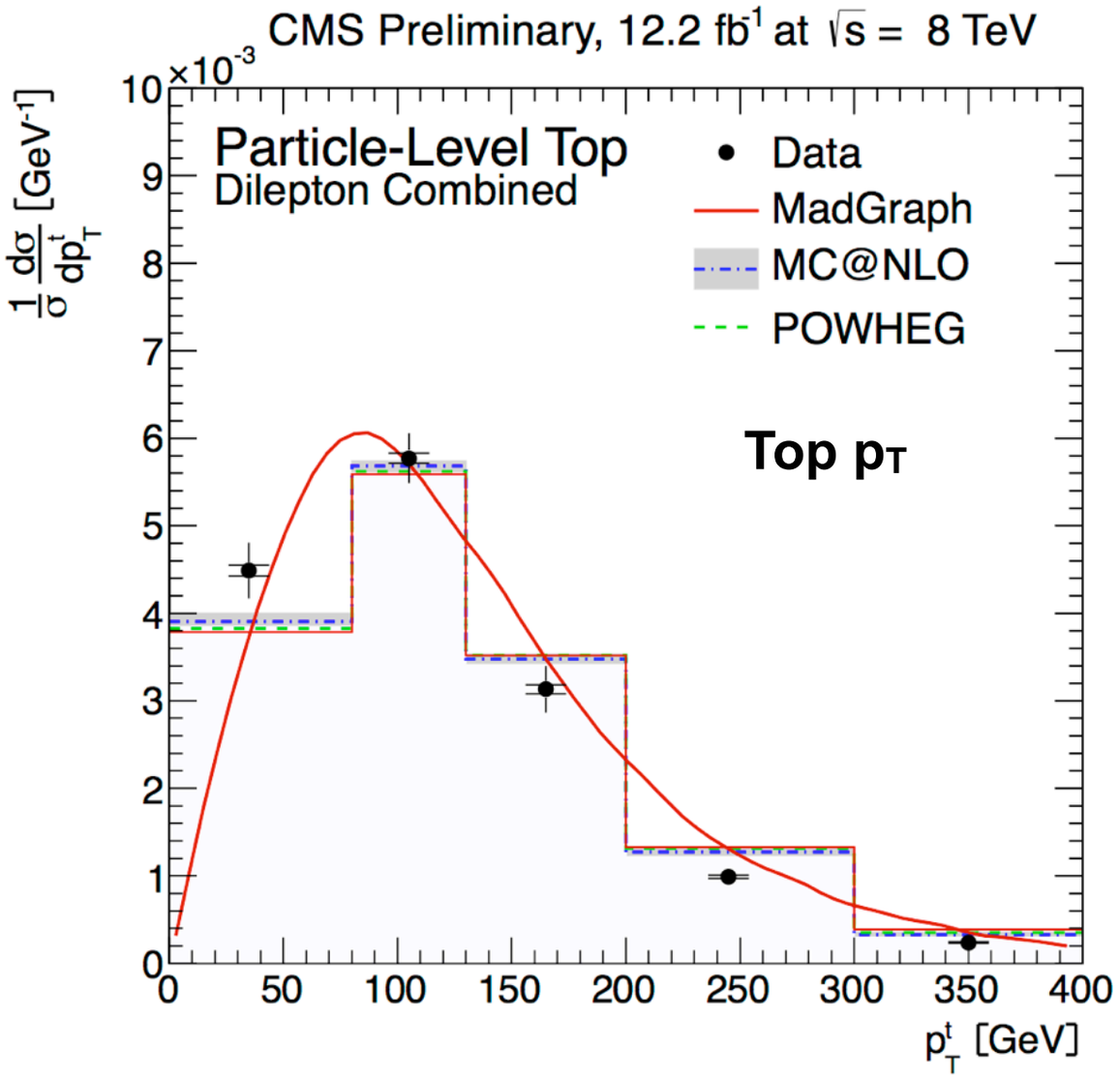
- We choose final state particles from the MC with slight modifications to make particle level objects
- An intermediate pseudoW is reconstructed using the four-vector sum of a lepton-neutrino pair. The lepton-neutrino pair combination is chosen by minimizing the quantity

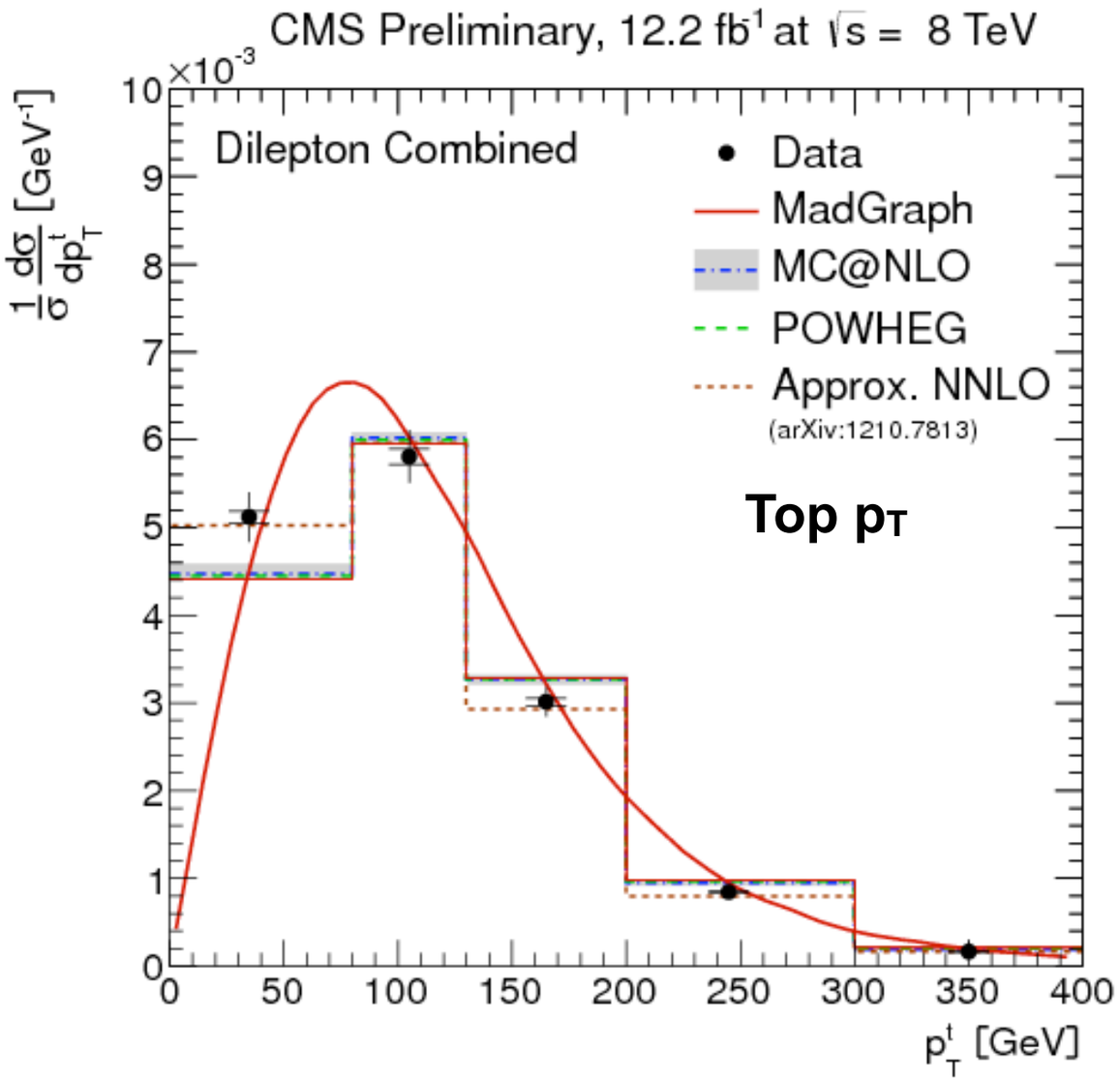
$$|m_{W1} - m_{W,true}| + |m_{W2} - m_{W,true}|, m_{W,true} = 80.385GeV$$

- Analogously the pseudoTop is reconstructed using the four-vector sum of a b-jet-

$$|m_{t1} - m_{t,true}| + |m_{t2} - m_{t,true}|, m_{t,true} = 173.5GeV$$

Particle-Level vs. Parton Level results





Particle-level quantities show similar trends to the parton-level counterparts

Ideally we would like to reduce hadronization and other scheme dependent uncertainties and improve communication between theorists and experimentalists.

Particle-level definition developed with ATLAS in the framework of the TOPLHCWG

Conclusions

- The Differential Top-Pair Cross-Section has been measured and presented as function of individual top quarks and the top-quark-pair system
  - Also measured as function of the decay products
- Results are from CMS-PAS-TOP-12-028
- A particle-level definition has also been developed
- Unfolded results at parton and particle level provide similar results
- Full 8TeV dataset results available soon
  - these may be the most precise measurement to be made at LHC

Thank you for listening!!