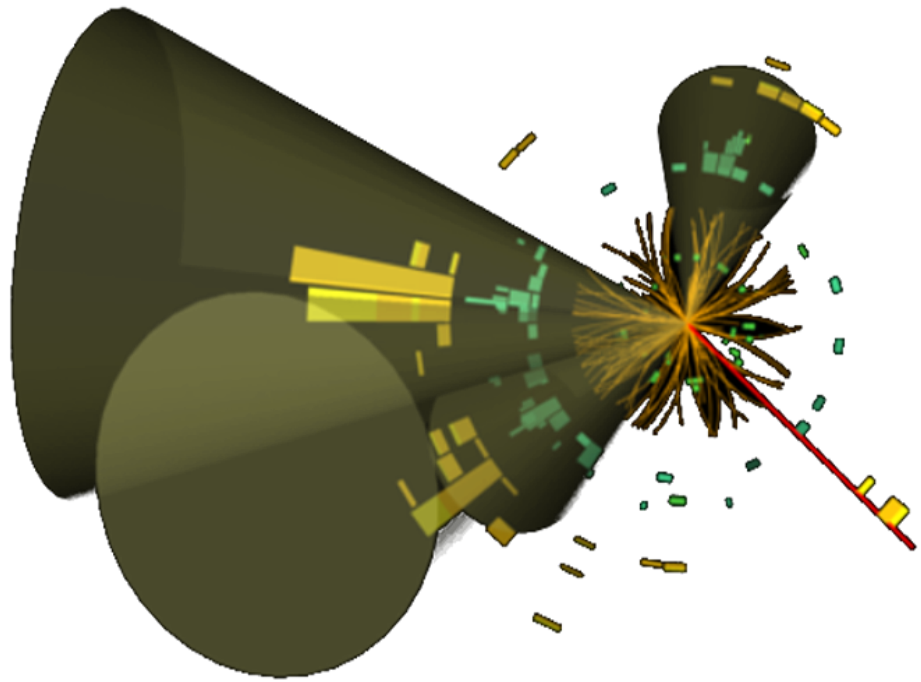
DIFFERENTIAL CROSS-SECTION MEASUREMENTS OF TOP QUARK PAIR PRODUCTION

at 8 TeV with the ATLAS Detector

15. September 2015



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on behalf of the ATLAS Collaboration

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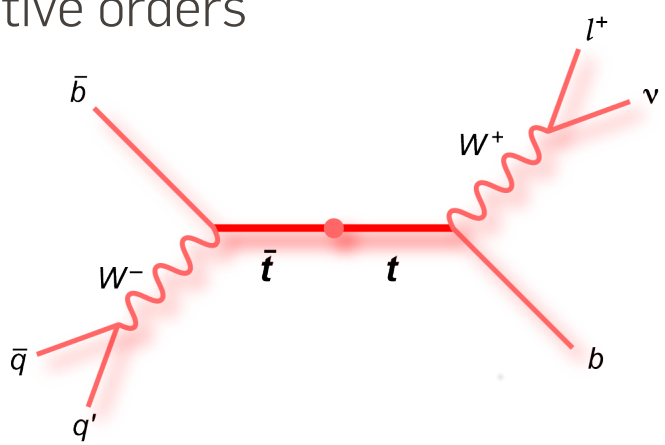
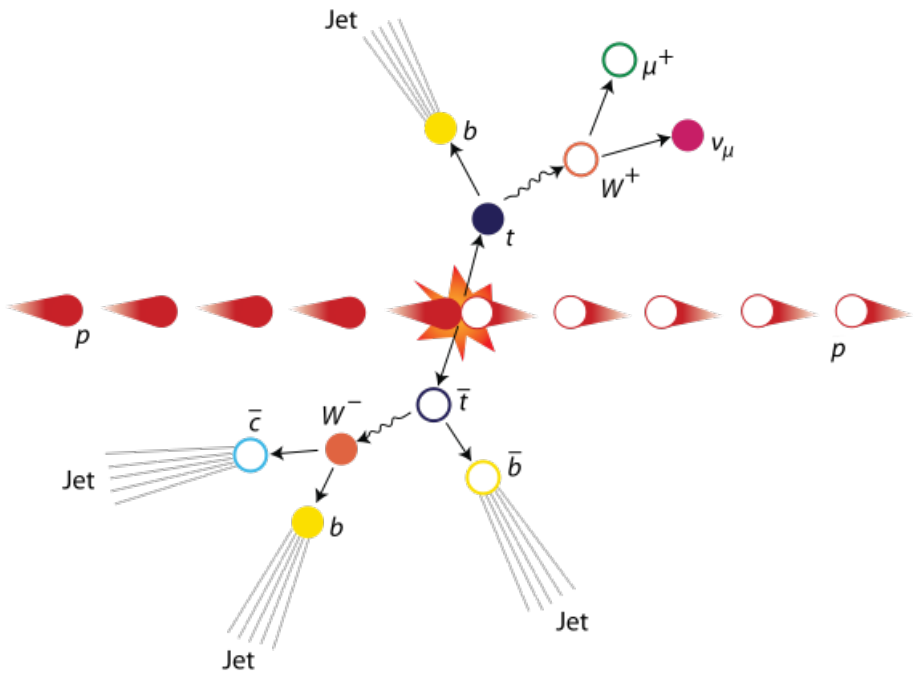
1. Large LHC top pair production cross section means there are lots of tops to study
   - → Can search for resonant top production from exotic decays
   - → Observe new physics from unexpected behaviour in tails of differential distributions
2. Top quark pairs are leading background for $t\bar{t}H$ and WH Higgs analyses and BSM searches
   - → To understand Higgs/BSM results, need to understand $t\bar{t}$
3. Differential distributions are tool to compare
   - → MC generators
   - → QCD radiation models
   - → PDF sets
   - → Calculations to different perturbative orders



SELECTION + RECONSTRUCTION

Pseudo-Top reconstruction of $t\bar{t}$ system keeps strong correlation with parton-level kinematics while reducing dependence on details of Monte Carlo simulation



Event Selection

Lepton: $p_T^{\ell} > 25$ GeV, $|\eta^{\ell}| < 2.5$, Triggered

Jets: Anti-k_T 0.4, $p_T^{\text{jet}} > 25$ GeV, $|y^{\text{jet}}| < 2.5$

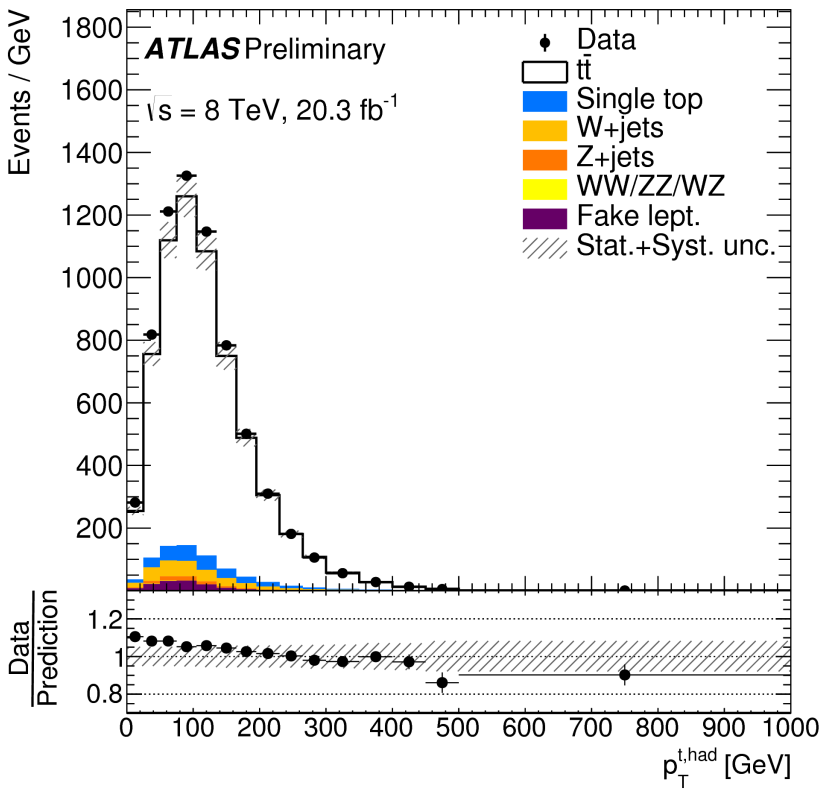
Event: =1 lepton, ≥ 4 jets, ≥ 2 b-jets

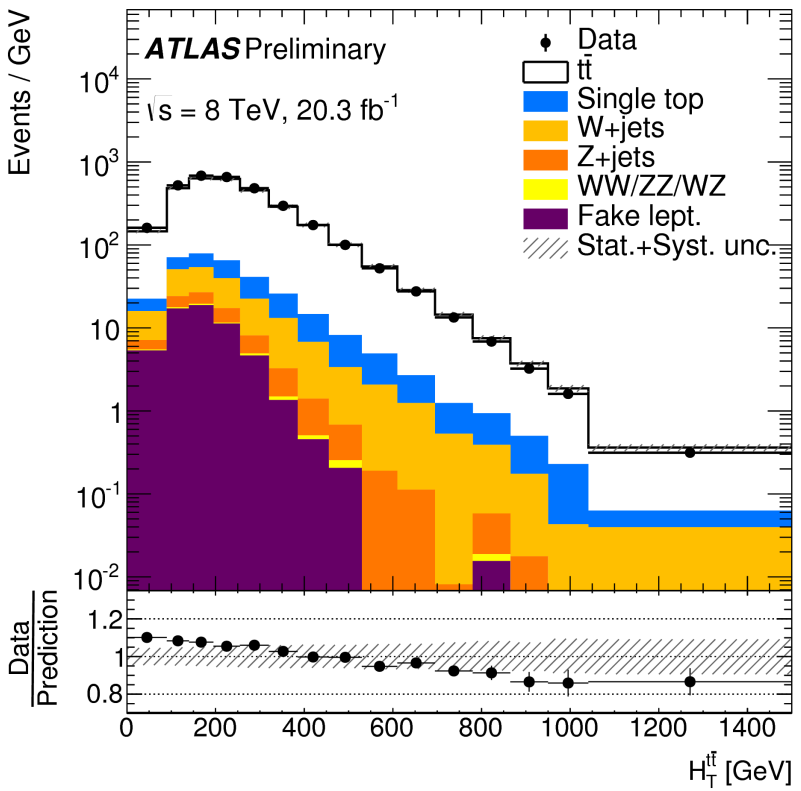
Pseudo-Top Reconstruction

1. Reconstruct neutrino p_z using W-mass constraint
2. Build leptonic W from lepton and neutrino
3. Select two highest p_T b-jets
4. Build leptonic top from W and b-jet closest in ΔR to lepton
5. Create hadronic W from two non b-tagged jets with invariant mass closest to m_W
6. Build hadronic top from hadronic W and remaining b-jet

OBSERVABLES

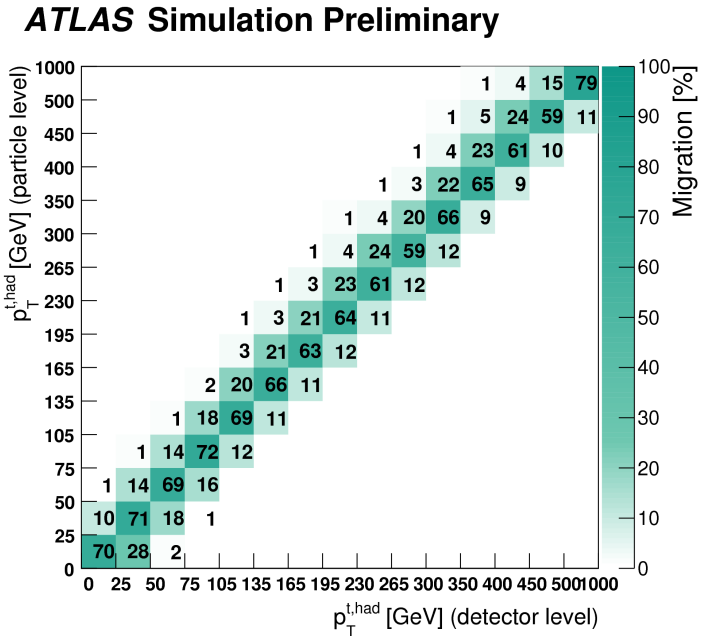
- → ATLAS studied number of 'classic' observables (p_T^t, $|y^t|$, $m_{t\bar{t}}$, $p_T^{t\bar{t}}$, $|y^{t\bar{t}}|$, $\Delta\phi^{t\bar{t}}$)
- → Also studied variables inspired from dijet-physics, e.g. out-of-$t\bar{t}$ plane transverse momenta, scalar sum of jet and lepton p_T (H_T), and more
- → The goal is modelling
  - → Need variables specifically sensitive to different PDF sets, additional radiation associated to $t\bar{t}$ pair, and new physics

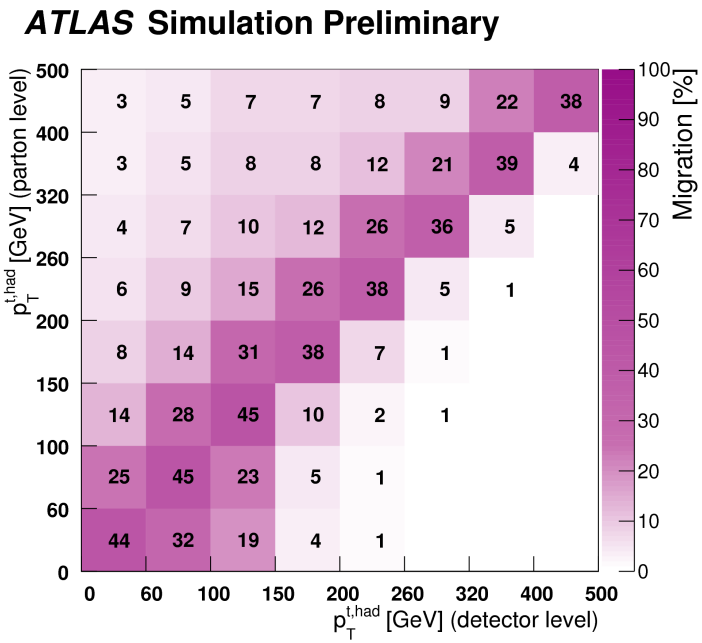




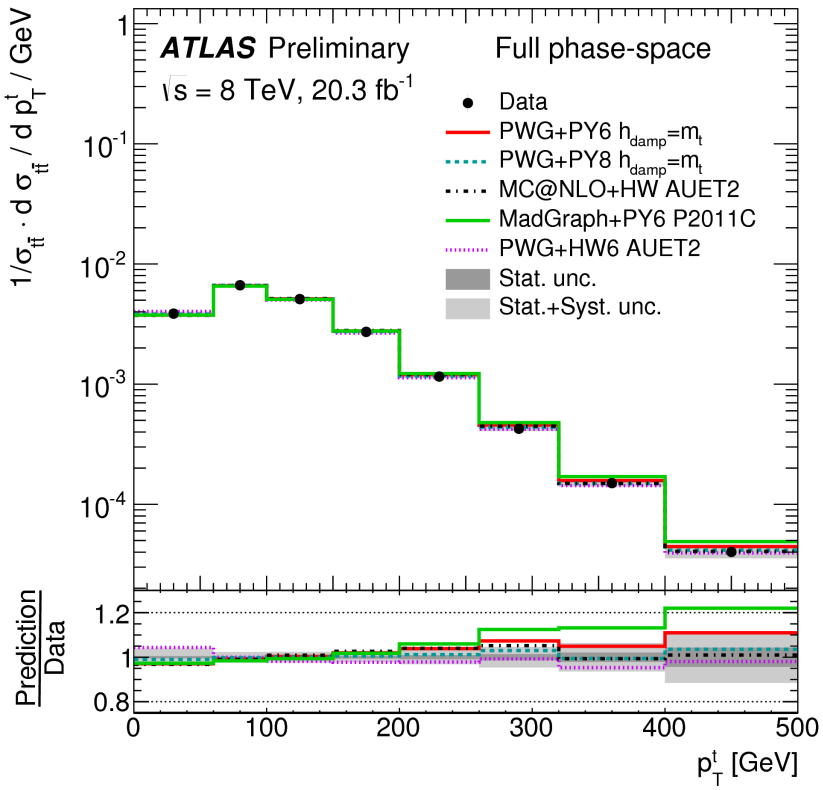
UNFOLDING

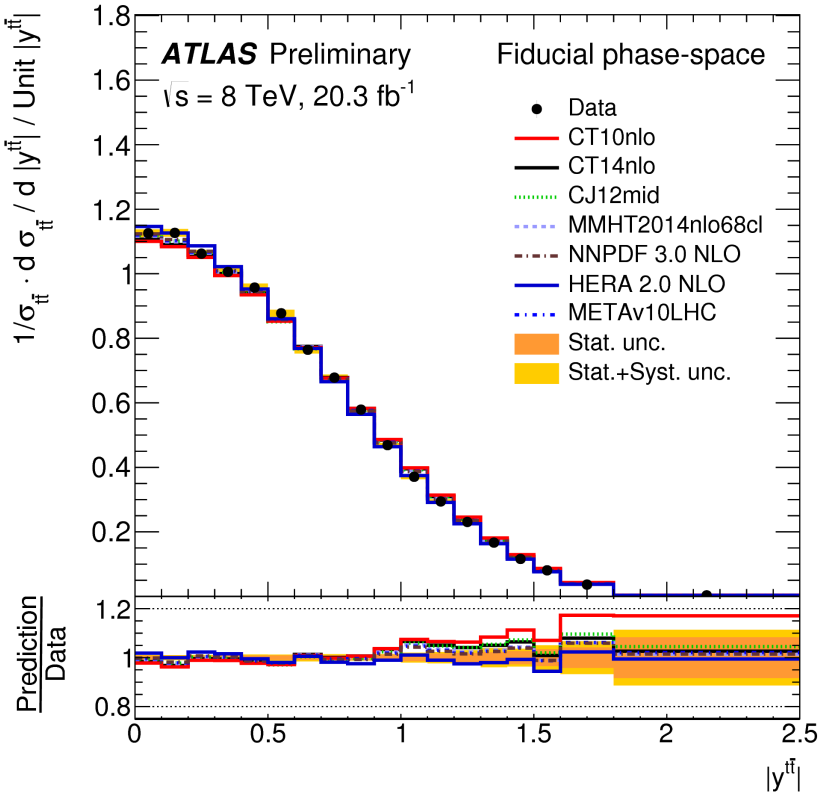
- → Corrects for detector resolution, acceptance, and reconstruction algorithms
  - → Iterative Bayesian used to unfold resolution effects
- → Measurements perfomed at both particle and parton levels
  - → Extrapolates from detector level measurements
  - → Particle level unfolding corrects for detector effects and reconstruction
  - → Parton level extends further into the entire phase space
- → Allows 'detector-free' comparison against theoretical predictions and measurements from other experiments





RESULTS!

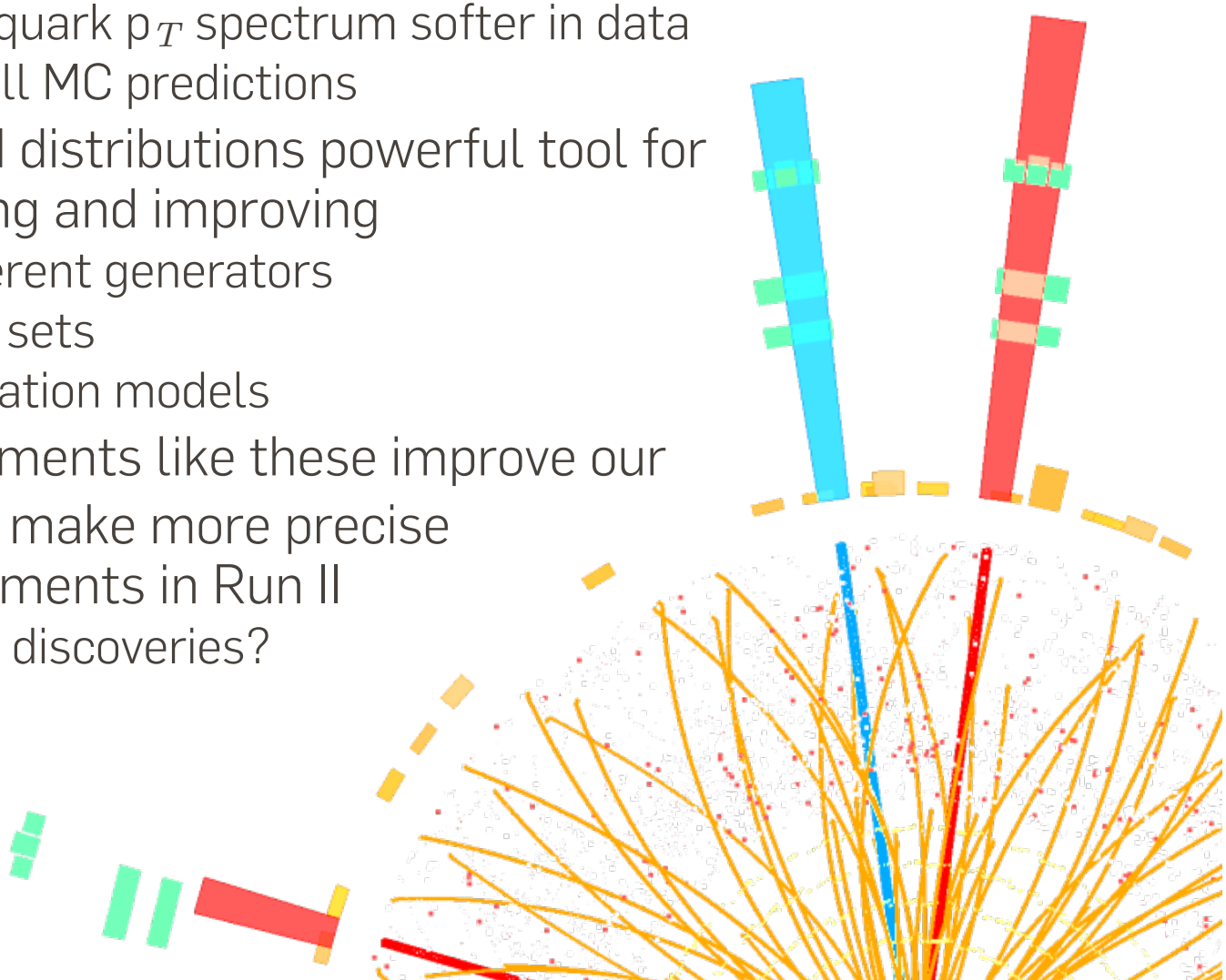




- → Unfolded distributions produced for both fiducial and full phase spaces
- → Data/MC comparisons against Powheg + Pythia6/8, Powheg + Herwig, MC@NLO, and MadGraph
- → Difference between data and prediction at high p_T^t
  - → Tension between data and MC also observed in tails of $H_T^{t\bar{t}}$ and $y_{t\bar{t}}$
  - → Note improvement in Data/MC agreement with newer PDF sets

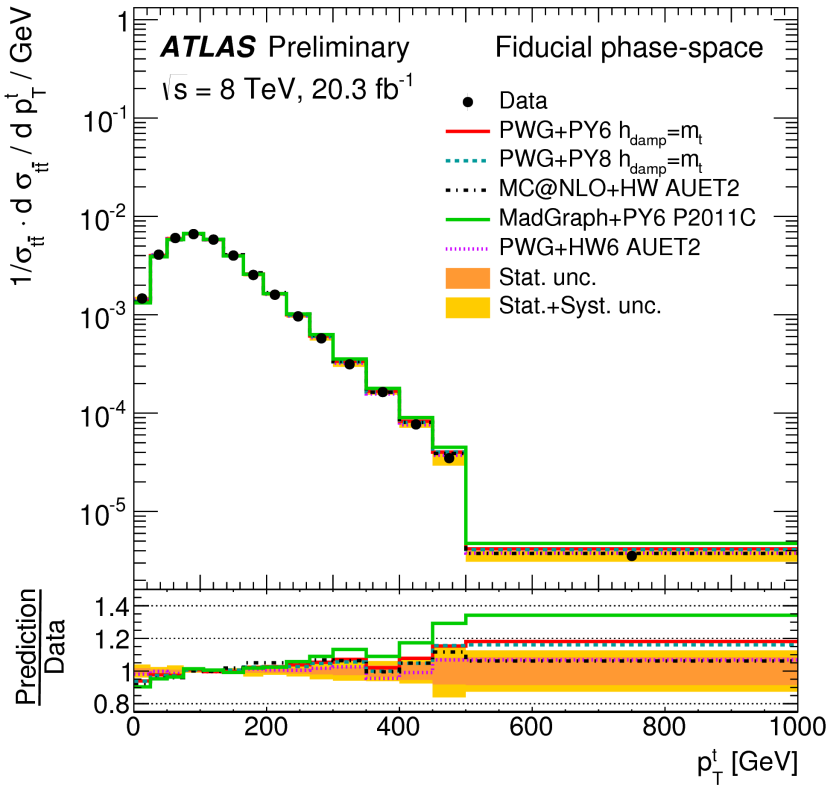
CONCLUSIONS

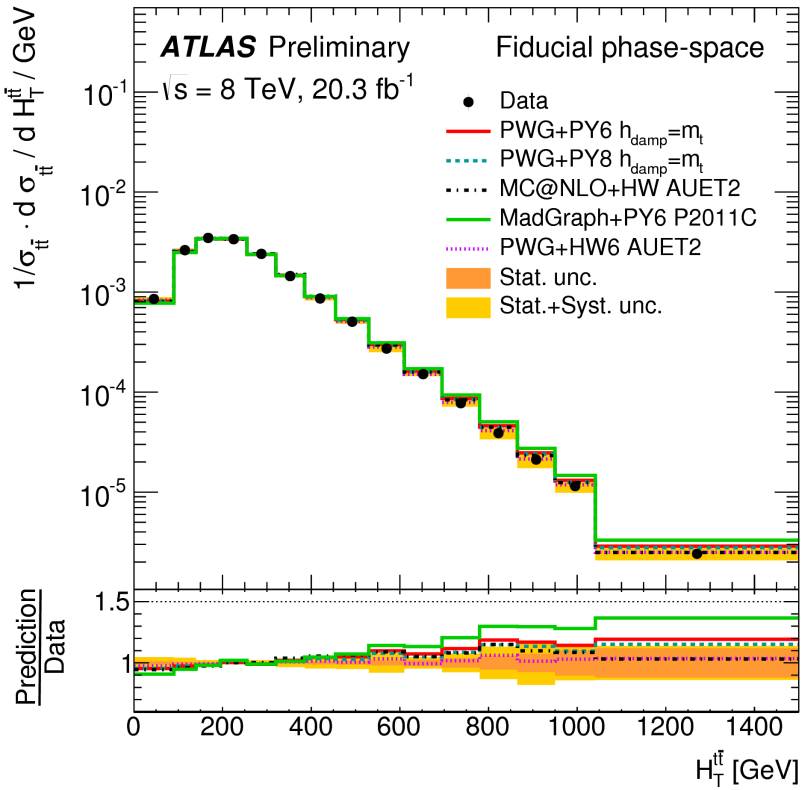
- → ATLAS has produced particle and parton level differential measurements of top quark pair production at 8 TeV
- → Overall good agreement between data and Monte Carlo
  - → Top quark p_T spectrum softer in data for all MC predictions
- → Unfolded distributions powerful tool for comparing and improving
  - → Different generators
  - → PDF sets
  - → Radiation models
- → Measurements like these improve our ability to make more precise measurements in Run II
  - → New discoveries?



BACKUP SLIDES

MORE DIFFERENTIAL PLOTS





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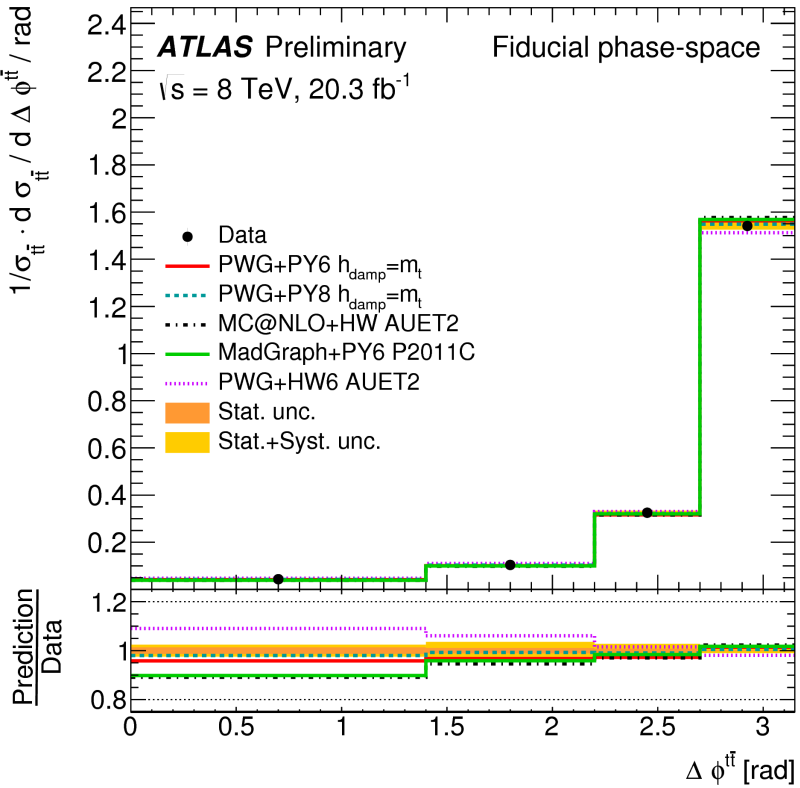
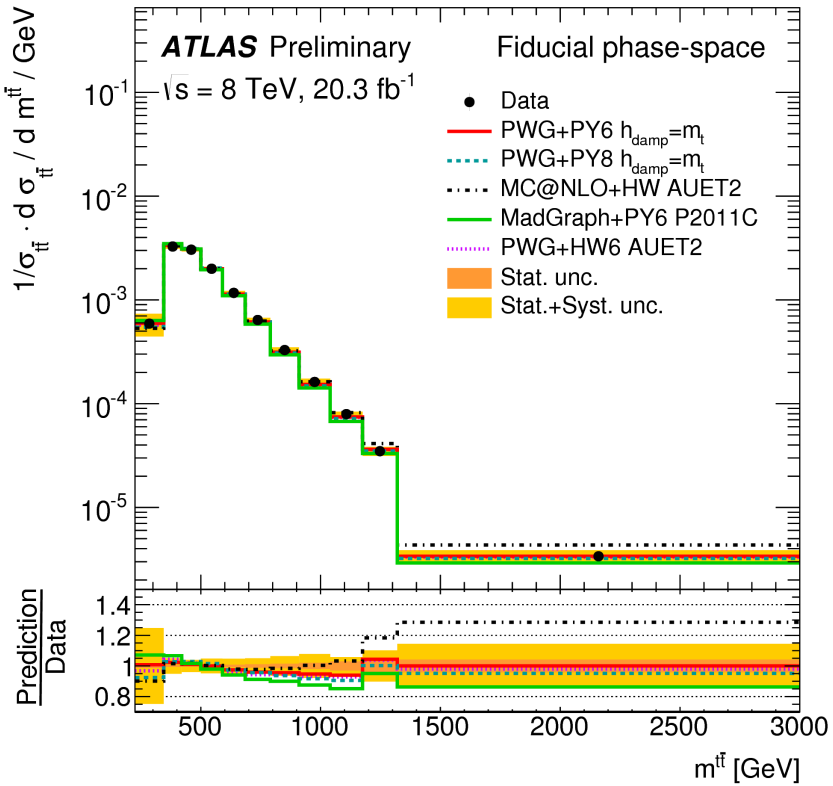
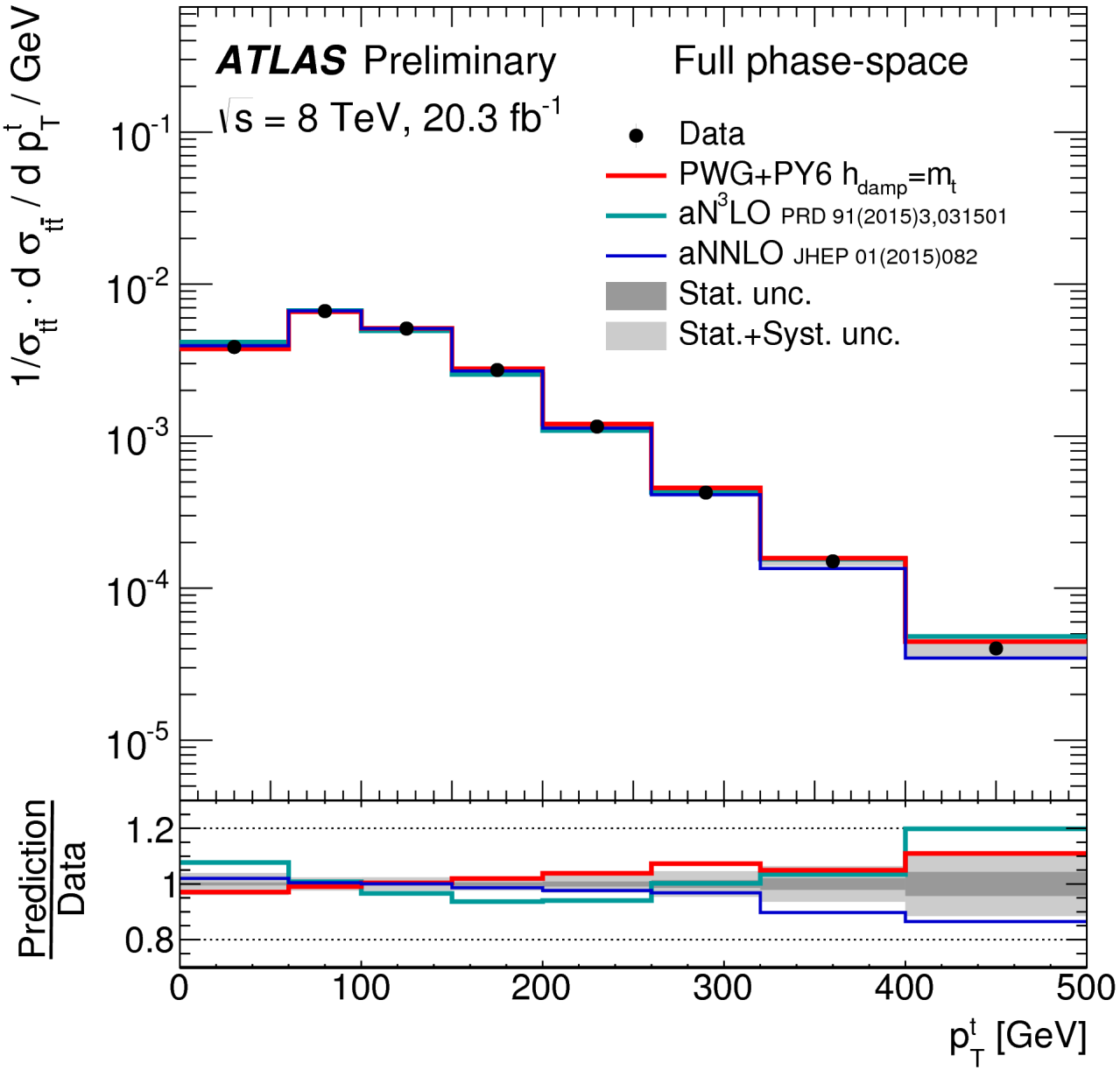
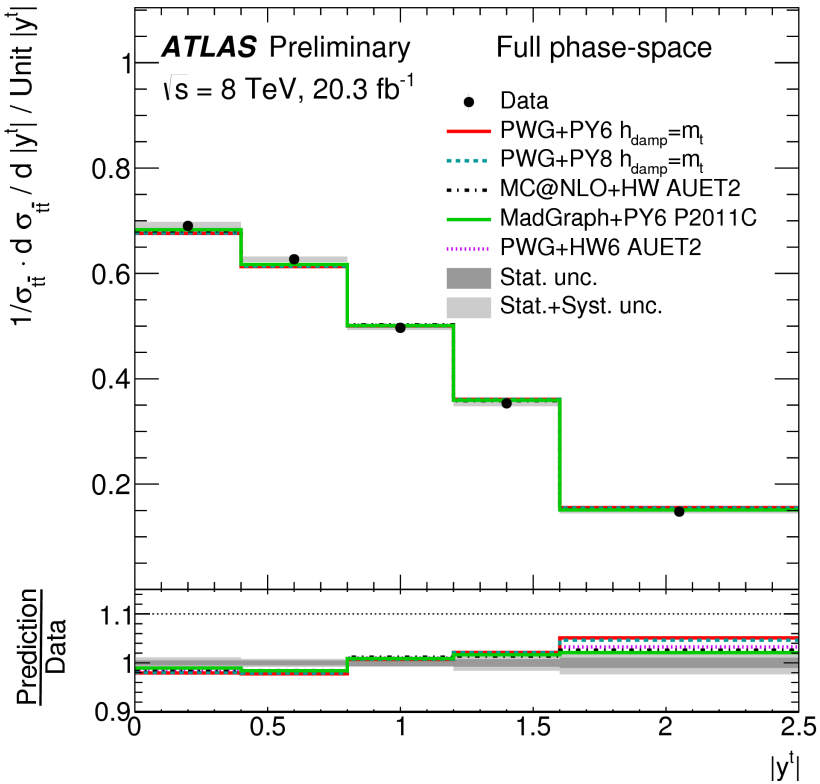


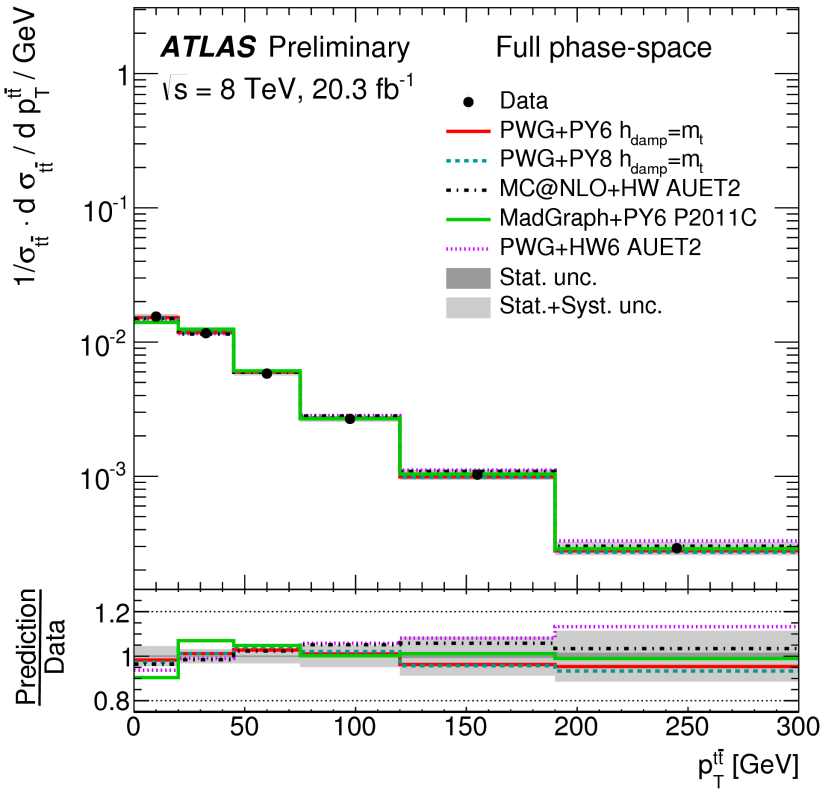


COMPARING PERTURBATIVE ORDER CALCULATIONS

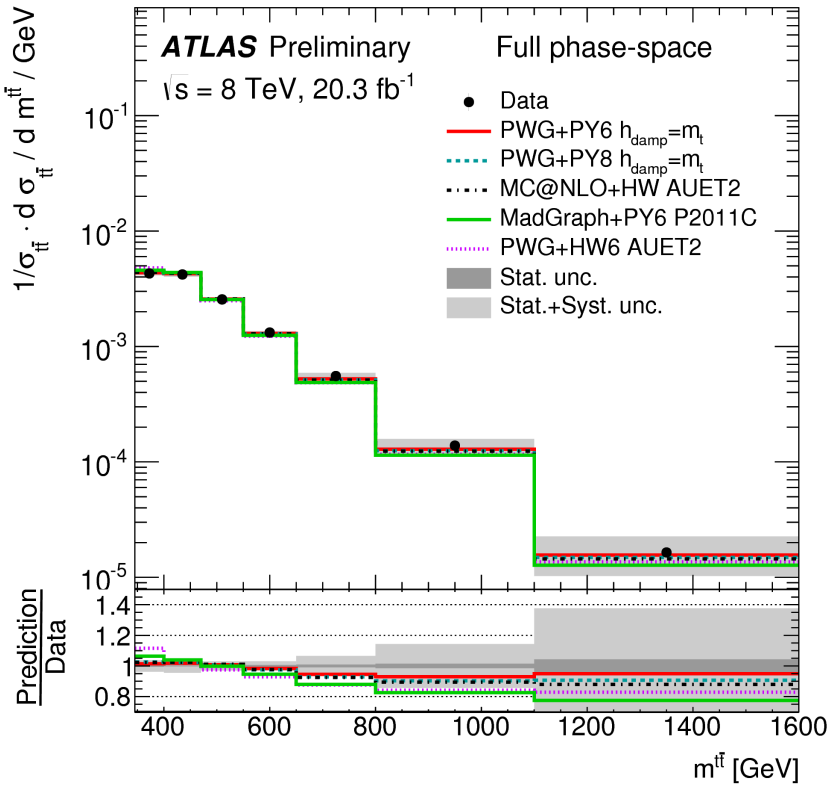


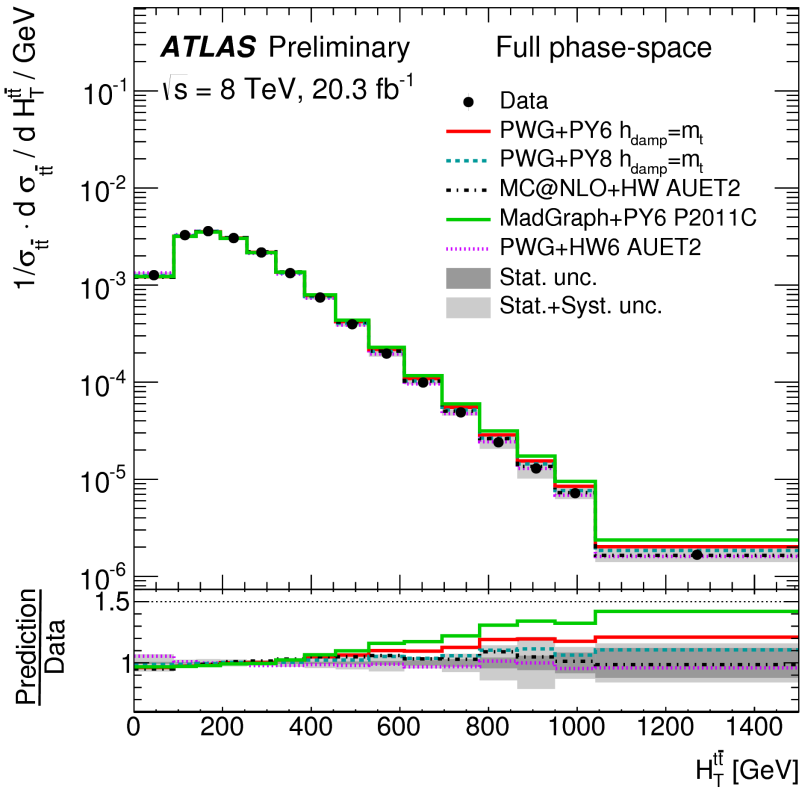
FULL PHASE-SPACE DIFFERENTIAL PLOTS





MORE FULL PHASE-SPACE DIFFERENTIAL PLOTS





JUSTICE FOR PSEUDO-TOPS