Angular Dijet Analysis in ATLAS

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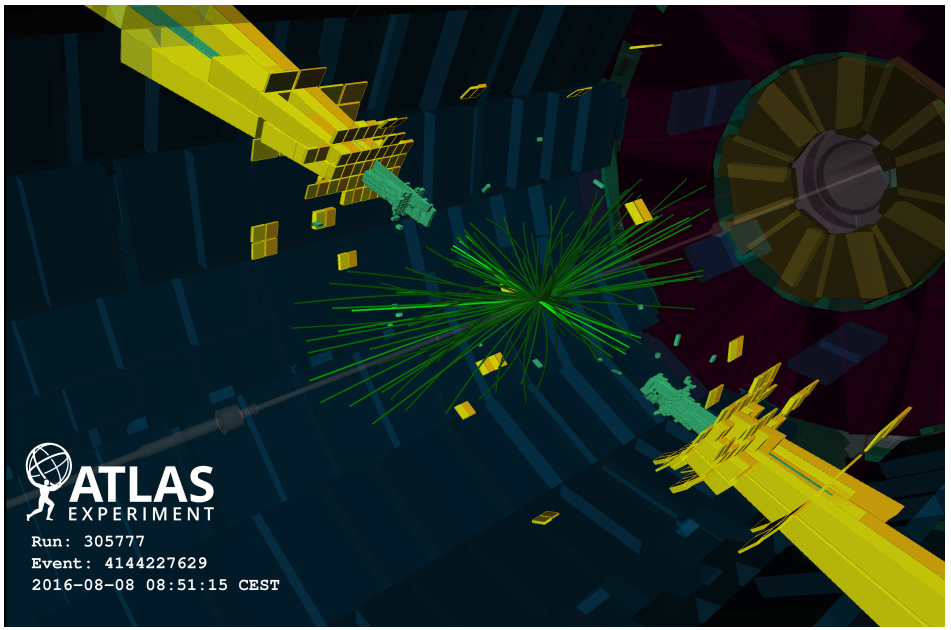
Doktoranddagen - September 19th 2017

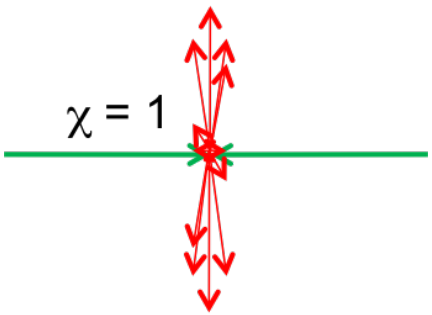
Dijet analysis and Lund

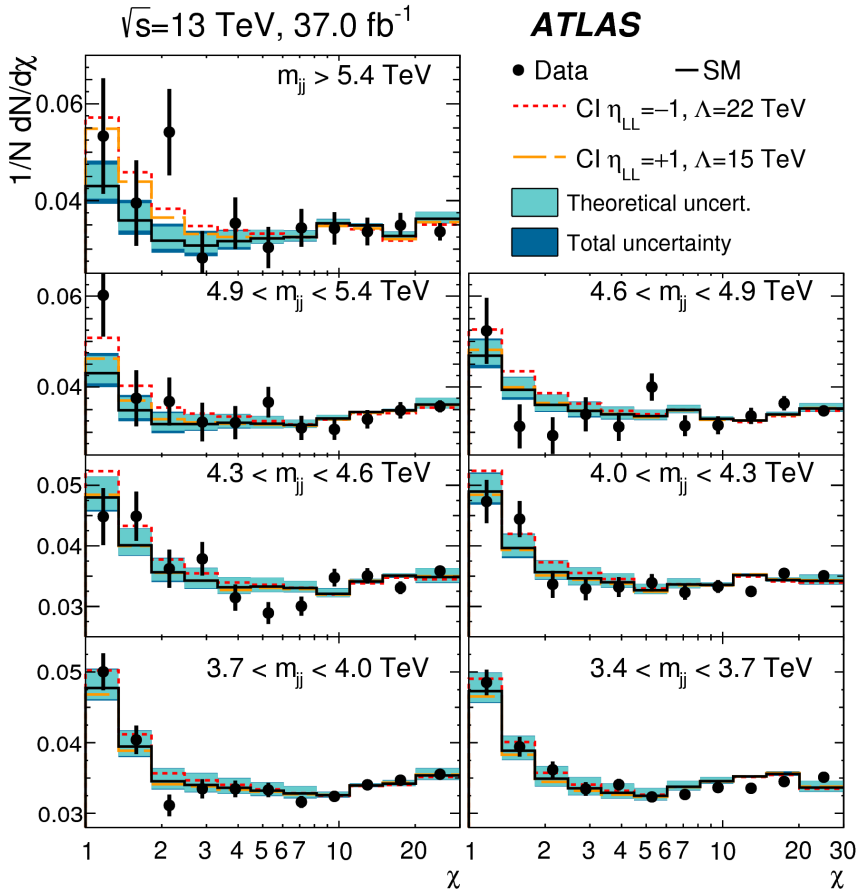
- The Lund ATLAS group has been involved in the dijet analysis since the beginning
- One of the most "simple" searches for physics beyond the Standard Model
- Divided in resonance and **angular search**



Current angular dijet analysis

- The angular distribution of the dijets is given by $\chi = e^{|y_1 - y_2|}$ and is divided into different mjj-bins
- The data is compared to Pythia simulation which is corrected with NLO EW κ-factors as well as NLO QCD k-factors
- The systematic uncertainties include JES, PDF, tune and scale uncertainty

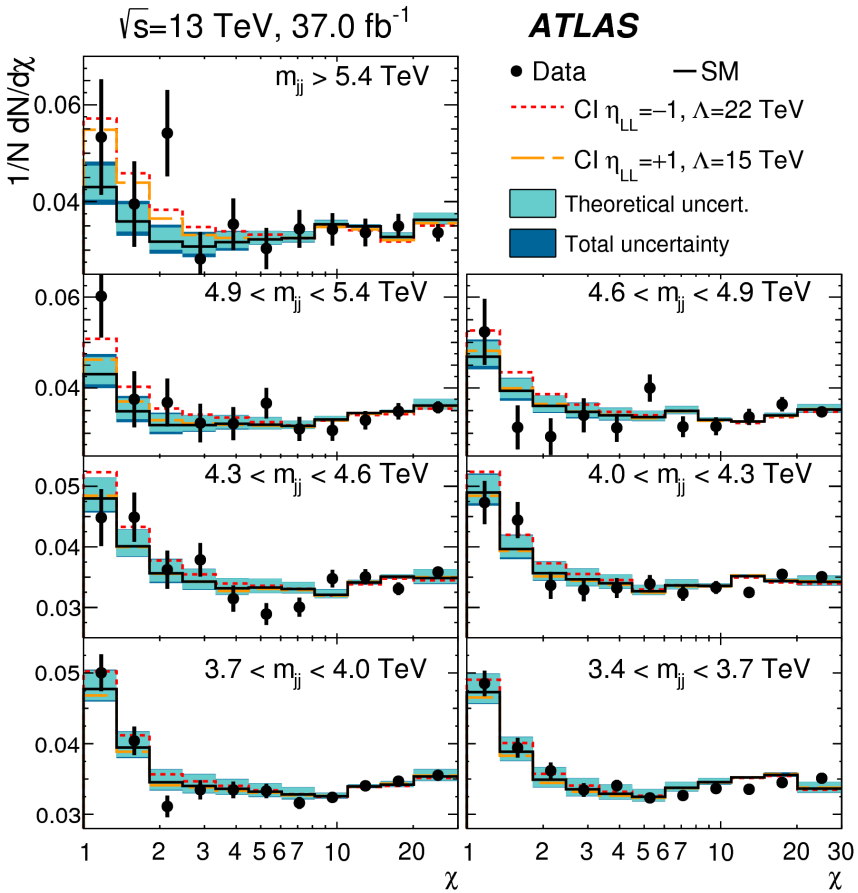




Full 2015+2016 dataset

Reducing systematic uncertainties

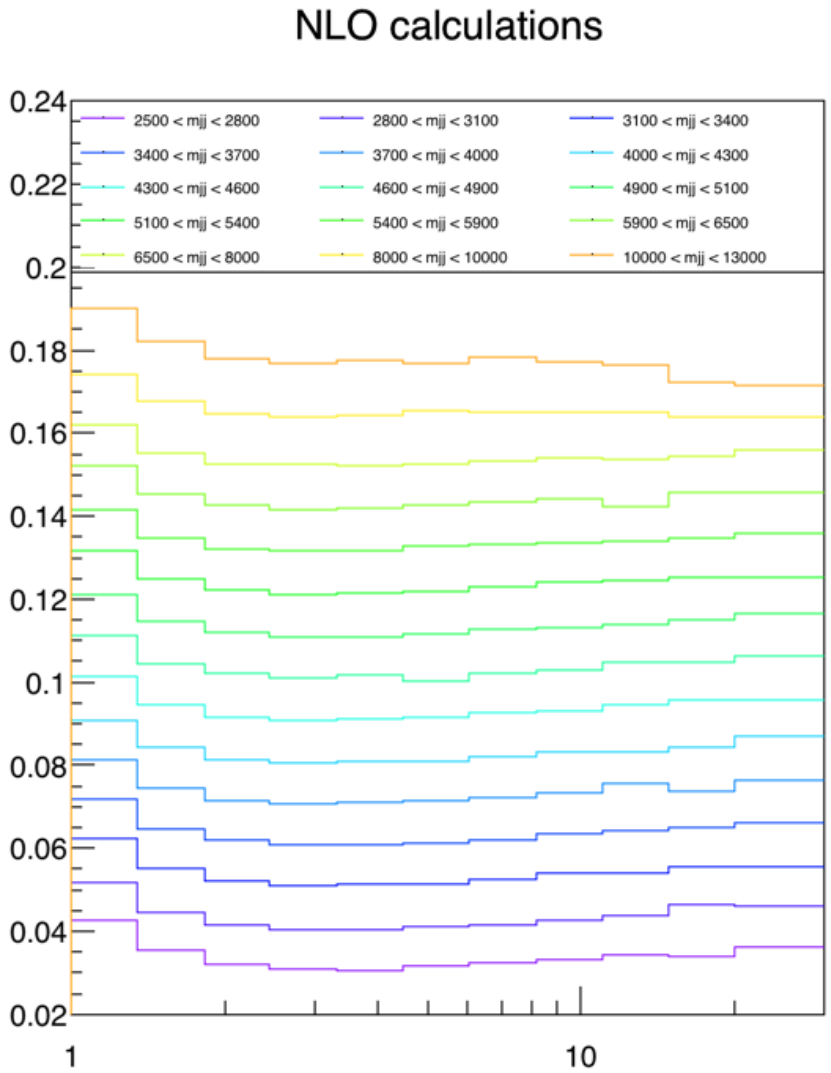
- We will soon be limited by systematic and not statistical uncertainties so need to start working on reducing them
- The different mjj-bins have similar systematic uncertainties
- The uncertainties will be reduced by taking the ratio between different mjj-bins
- This is a data-driven cancellation of systematic uncertainties



Full 2015+2016 dataset

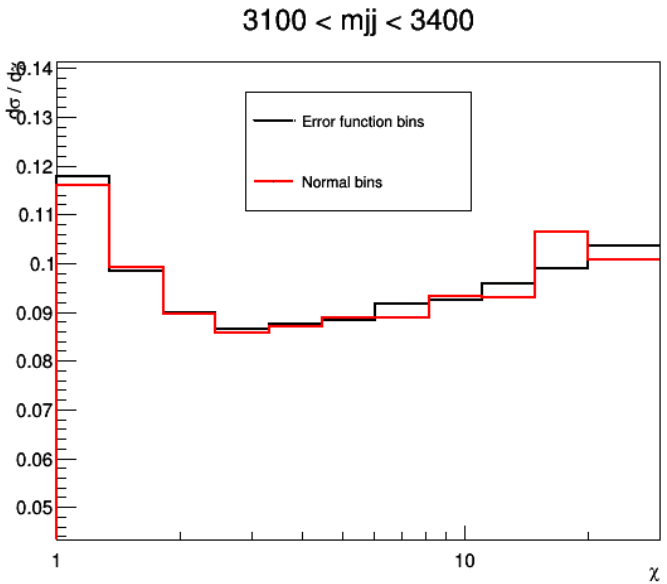
Problem with NLO QCD calculations

- The NLO QCD k-factors bring the background prediction from LO to NLO
- Big unphysical fluctuations at high χ
- More reliable calculations are needed for new ratio analysis



Solution to problem with NLO QCD calculations

- Interplay between phenomenology and the anti-kt algorithm gave the problem
  - Big positive weight from real part and corresponding weight from the subtraction term are going into different bins (can happen for both mjj and χ bins)
- Extensive studies with Johan Rathsman from Theoretical Physics has resulted in a solution
  - Black line (with solution) much smoother than red line (original)

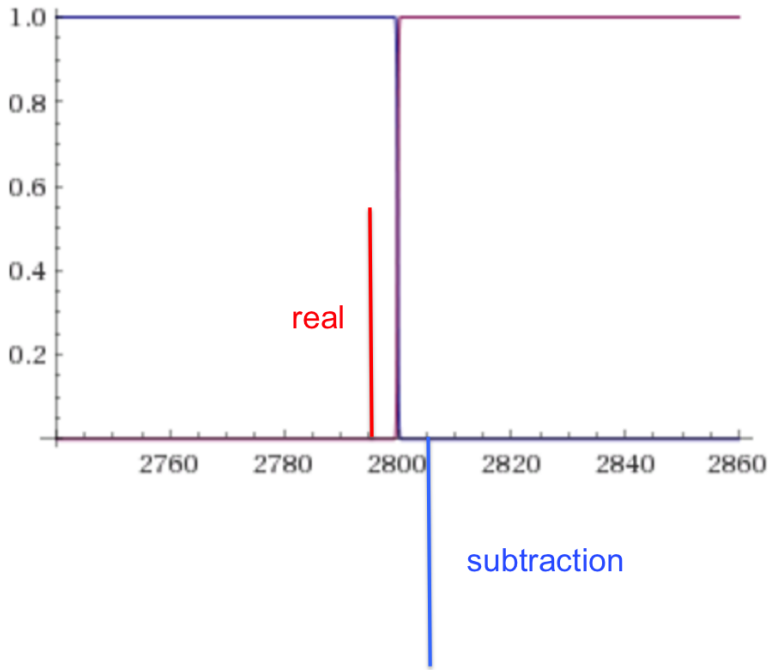


Solution to problem with NLO QCD calculations

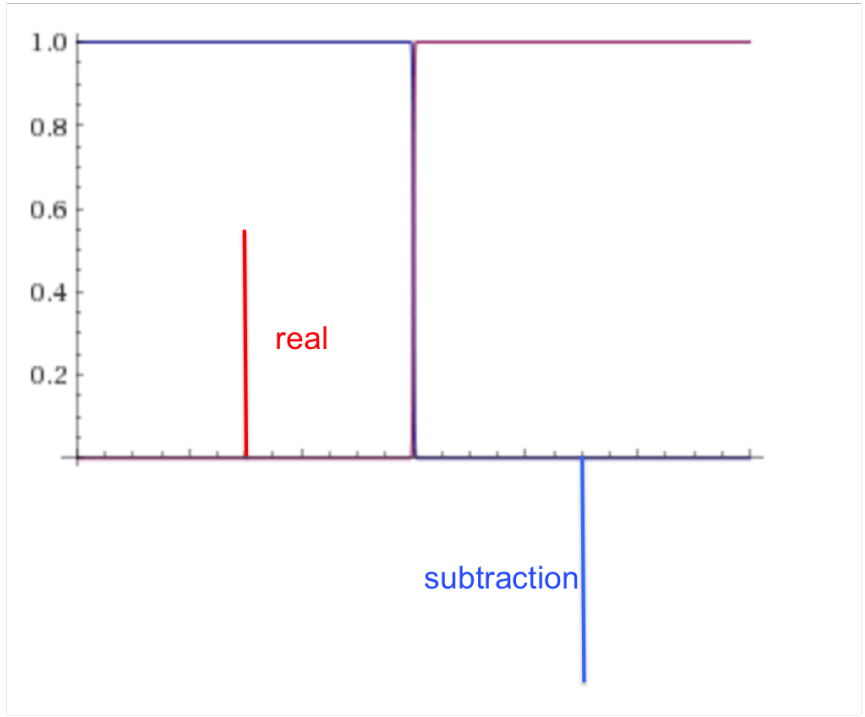
- Fluctuations at high chi are caused by big positive xs-weight from real part and corresponding negative xs-weight from the subtraction term going into different bins (mjj or chi)
  - Happening since soft radiation with large angle is not always captured by the jet algorithm - leading to change in kinematics
- Is solved by changing normal bins to soft bins given by error functions (see the next slides)
  - If xs-weights are close to a bin edge the weight will be split such that some of it goes into one bin and some of it goes into the other
  - The fraction going into each bin is given by the error function value
  - Error function bins are used both for χ and mjj

Normal bins

- With normal bins a big positive xs-weight from real part and a big negative xs-weight from the subtraction term can go into different bins

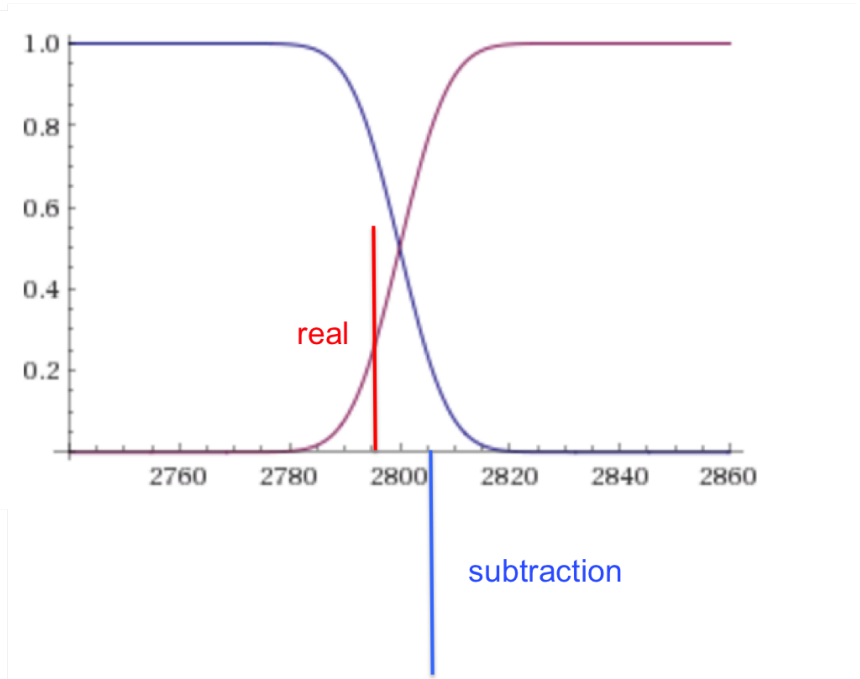


$\Rightarrow$

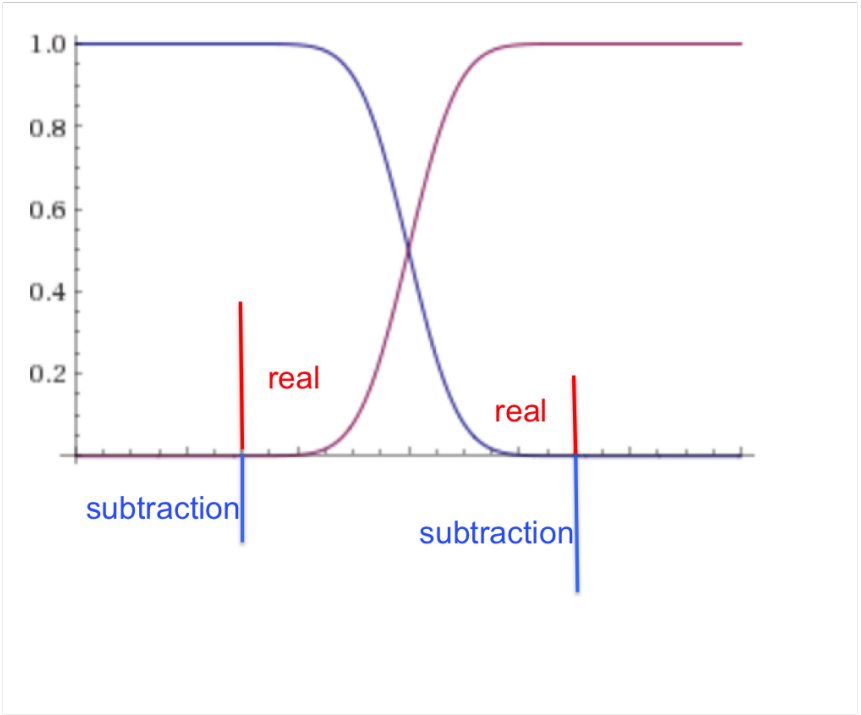


Error function bins

- With error function bins the positive and negative xs-weights will be split into both bins with a weight given by the value of the error function

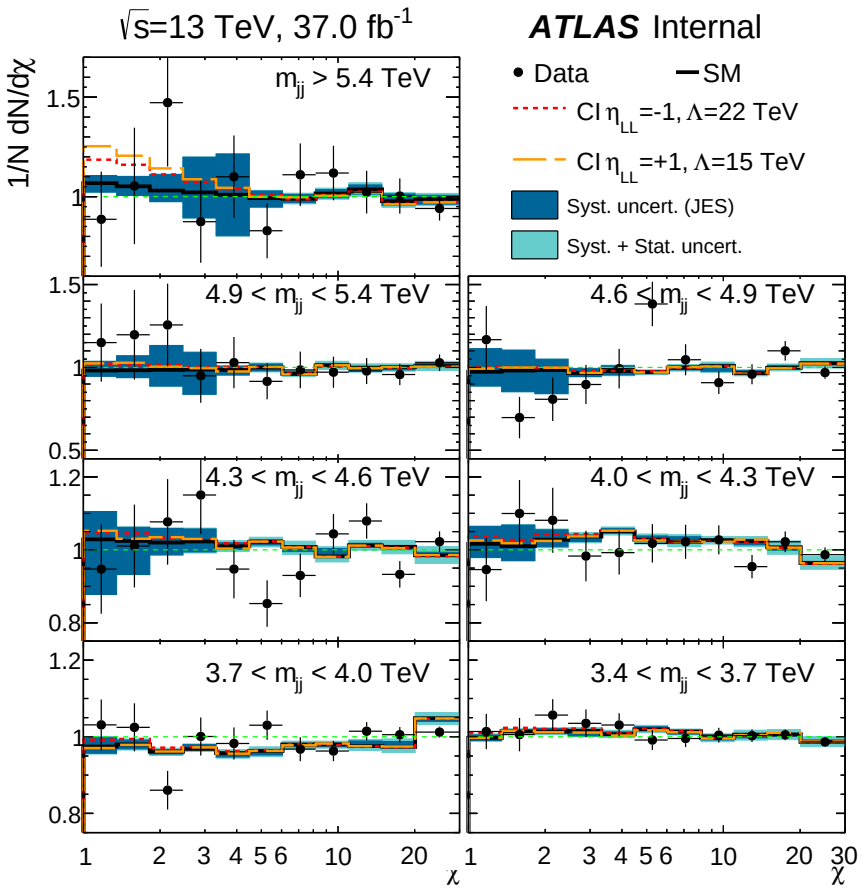


$\Rightarrow$

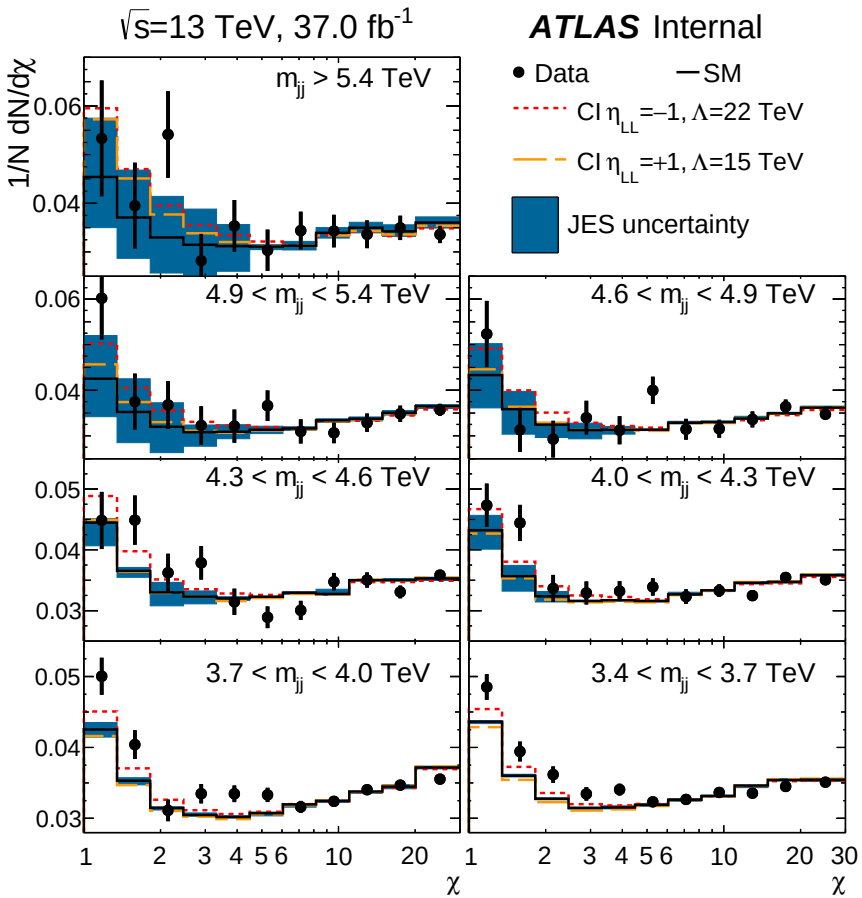


Comparing methods

- Using new k-factors
- Disclaimer: Only including JES uncertainty!



Ratio to bin below



Normal

Other work

- Implementing top tagging in dijet analysis (master student Yosse)
- High-pT JES uncertainty and E/p measurements (Millie in Melbourne)
- Combination of in-situ methods for JES uncertainty