Measurements of Forward Jet Production at CMS

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on behalf of the CMS Collaboration

DESY

19th Particles and Nuclei International Conference

Cambridge, 28th July 2011

Outline

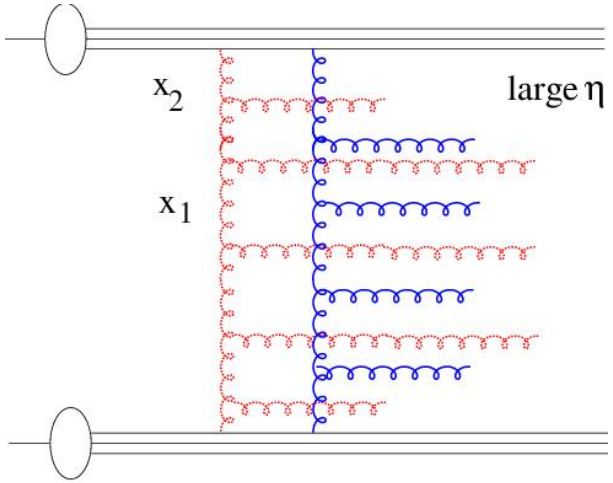
Motivation

High energy collisions

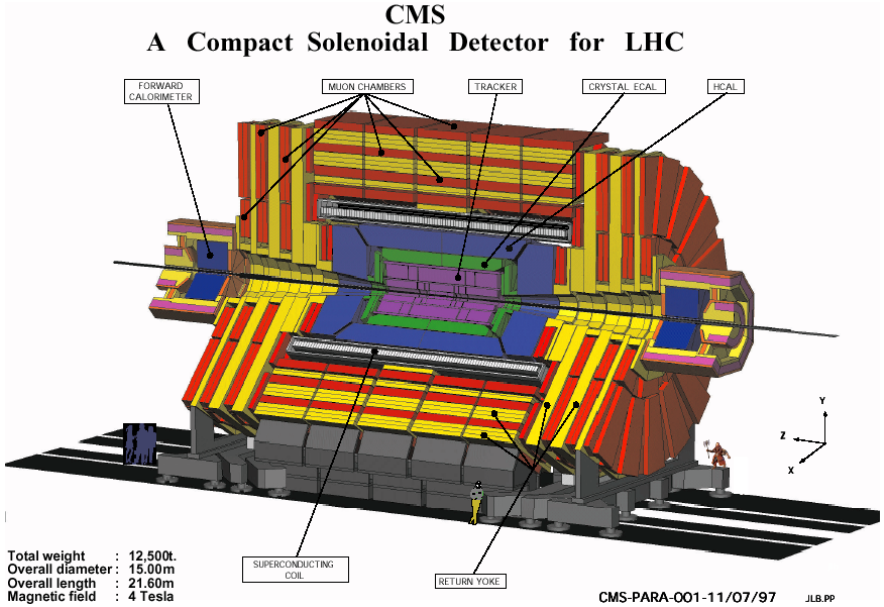
- Large parton densities are important
- Large phase space for QCD emissions
- High probability for multi-parton interactions

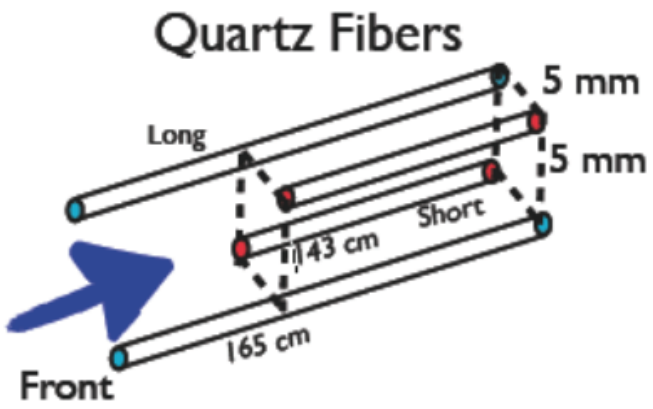
Forward region

- High sensitivity for additional radiation and multi-parton interactions
- Large phase space region can be explored



Hadronic Forward Calorimeter at CMS





Hadronic Forward (HF)

- Coverage: $2.9 < |\eta| < 5.2$
- Steel absorber with quartz fibres
- $\Delta\eta \times \Delta\phi = 0.175 \times 0.175$
- Alternating long (165 cm) and short (starting after 22 cm) fibres: identification of electrons and photons possible

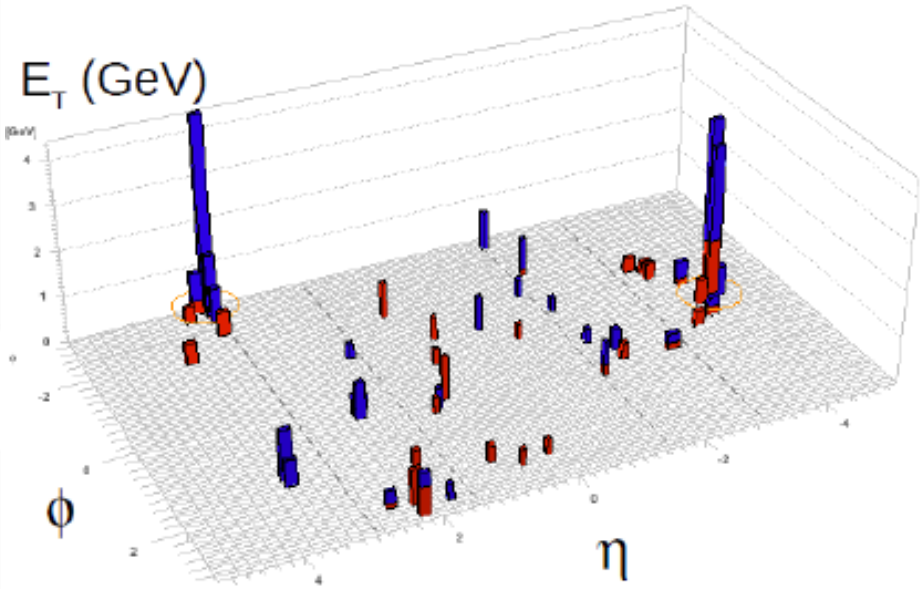
Inclusive Forward Jets – CMS PAS FWD10-003

Jets

- Jets built from Calorimeter information
- Anti-k_T algorithm with $R = 0.5$
- Application of jet quality criteria
- Consider jets with $p_T > 35\,\text{GeV}$ in $3.2 < |\eta| < 4.7$

Conditions

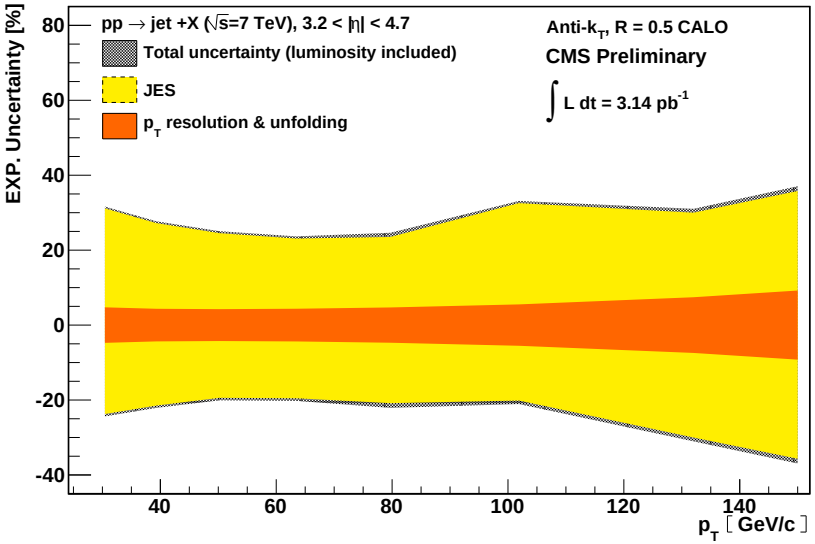
- Single jet trigger ($p_T > 15\text{GeV}$) fully efficient in region of measurment
- Integrated luminosity: $3.14\,\text{pb}^{-1}$



Systematic Studies for Inclusive Forward Jet Cross Section

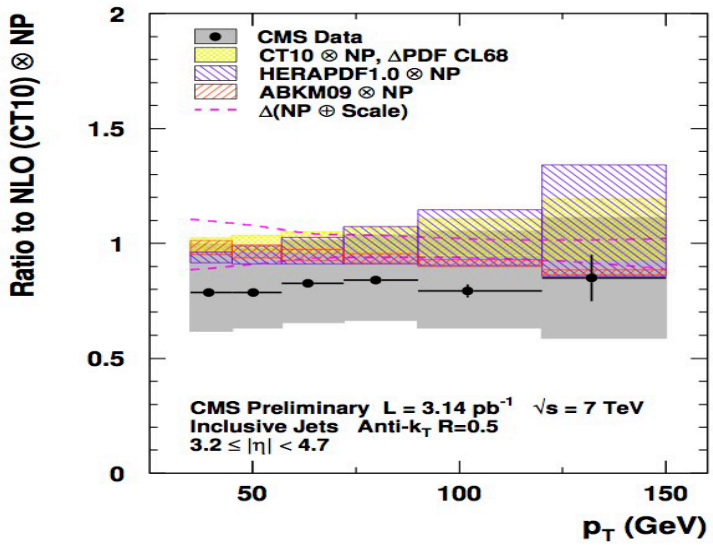
Experimental systematic effects

- Jet Energy Scale (20 – 30%)
- p_T resolution (for bin-by-bin corrections) (3 – 6%)
- Luminosity (4%)

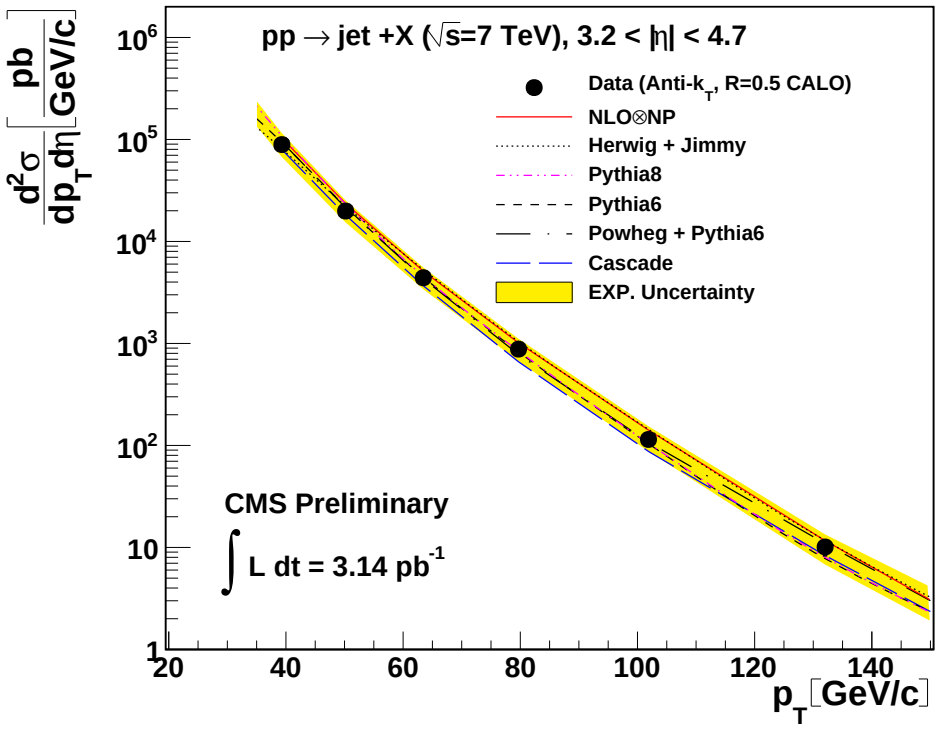


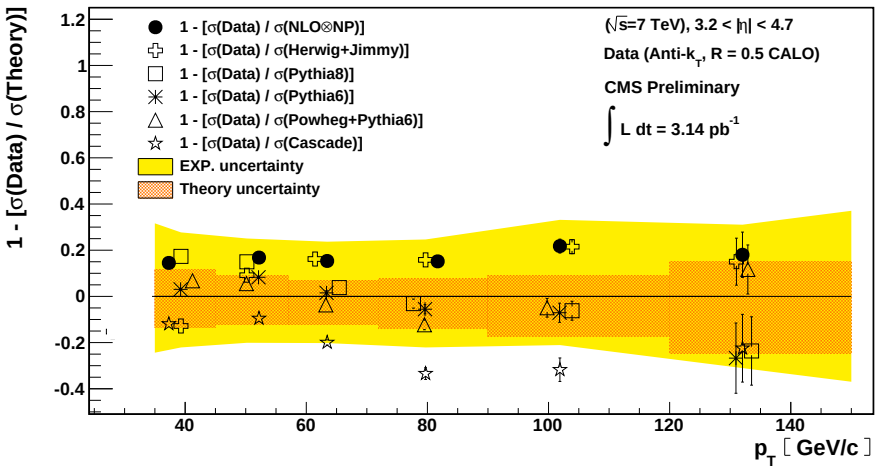
Theoretical uncertainties

- Non-perturbative effects (PYTHIA and HERWIG)
- Check with different PDFs
- Variation of μ_r and μ_f by a factor of 2



Forward Jet Cross Section





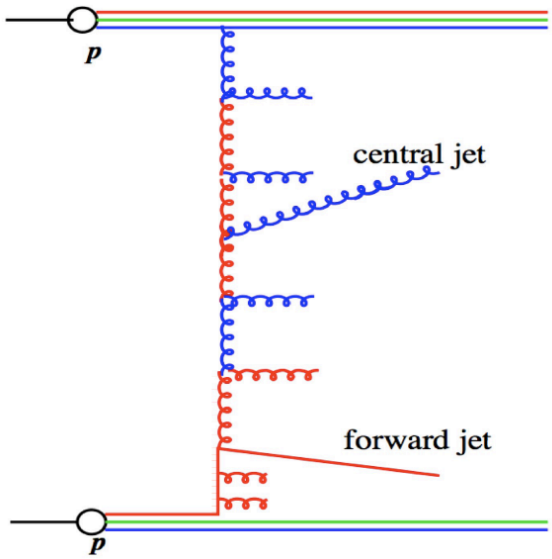
Corrections to hadron level utilising bin-by-bin method

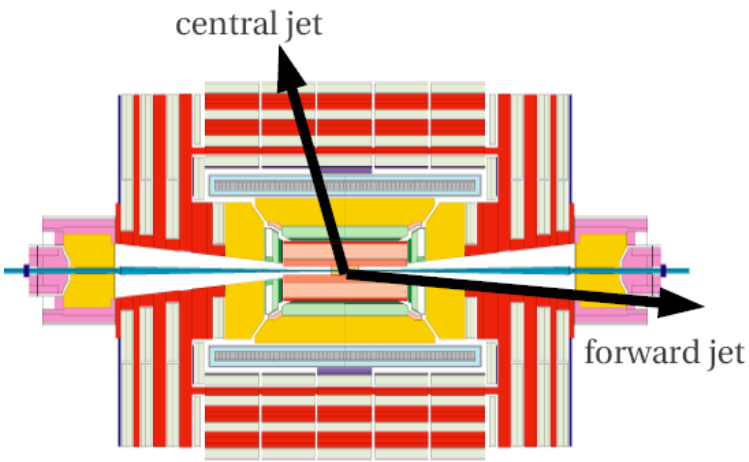
- Hadron-level predictions are in good agreement with the data
- Fractional differences between forward jet spectra measured and the predictions show shape variations at high p_T for CASCADE

Forward and Central Jets – CMS PAS FWD10-006

Simultaneous production of central and forward jets

- Leading jet in central and forward region are investigated
- $p_T > 35\,\text{GeV}$
- Central region: $|\eta^c| < 2.8$
- Forward region: $3.2 < |\eta^f| < 4.7$

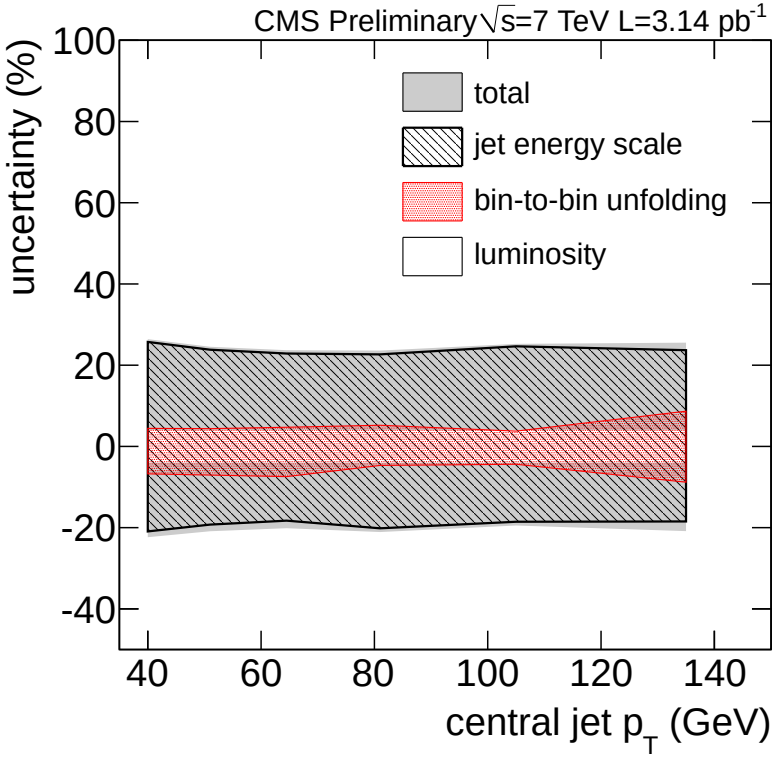


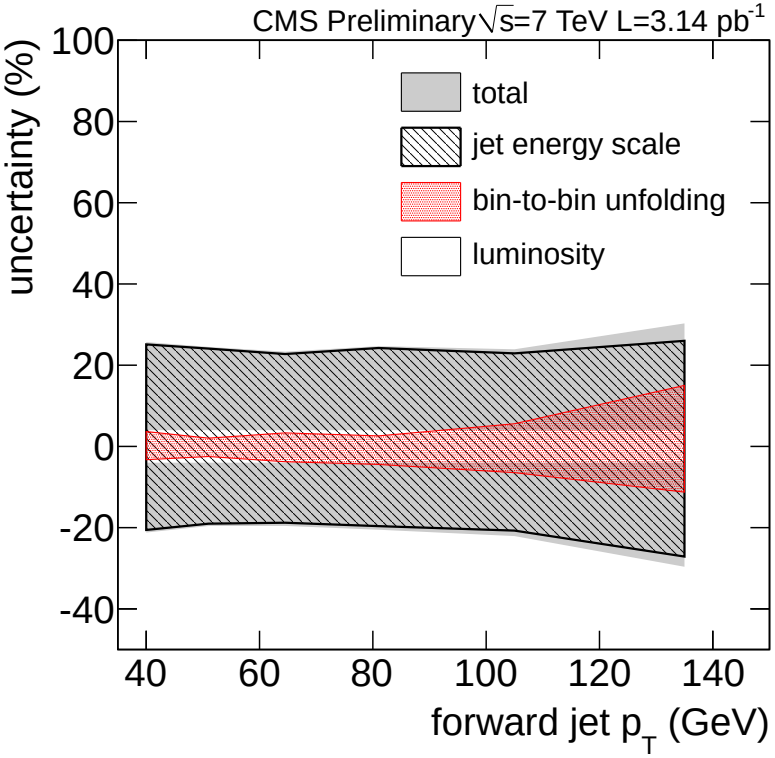


Systematic Studies for Forward-Central Jets

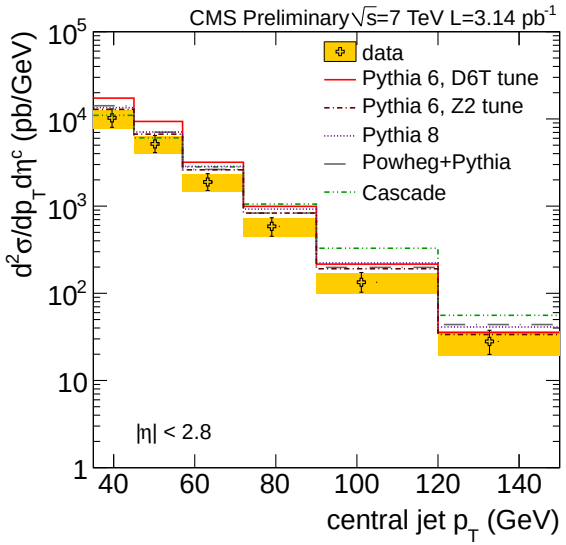
Experimental systematic effects

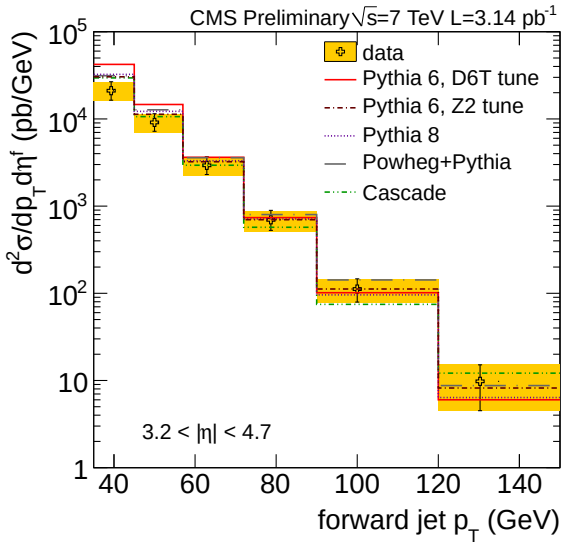
- Effect of jet energy scale (25%)
- Effect of luminosity (4%)
- Variation of bin-by-bin correction factors from different MCs (5 – 15%)

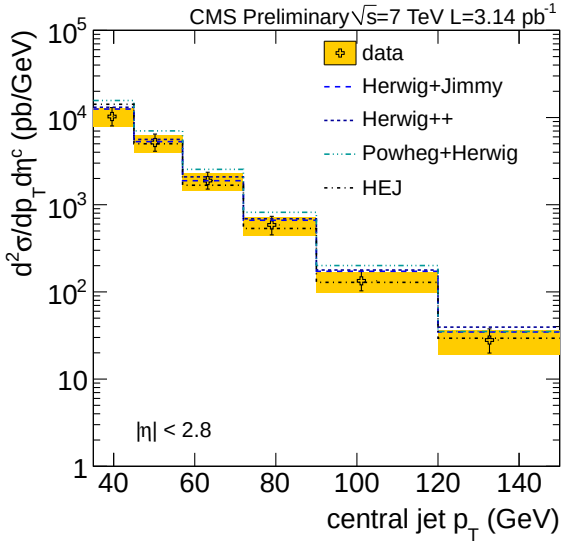


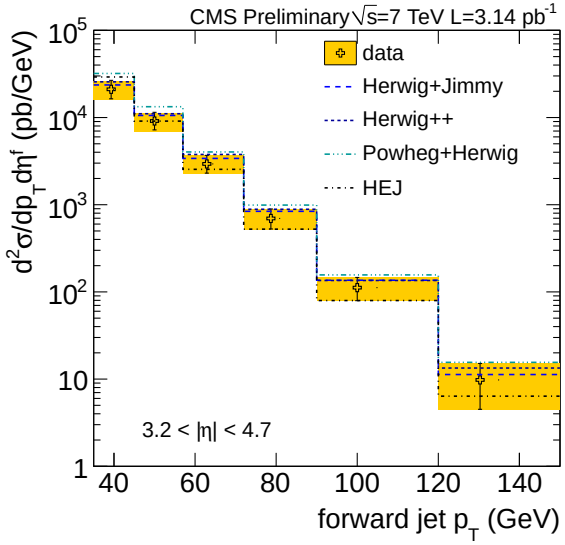


Forward and Central Jet Cross Sections









Corrections to hadron level

- Bin-by-bin method
- Distributions re-weighted at hadron level

Results

- PYTHIA fails in the central region
- HERWIG does a better job

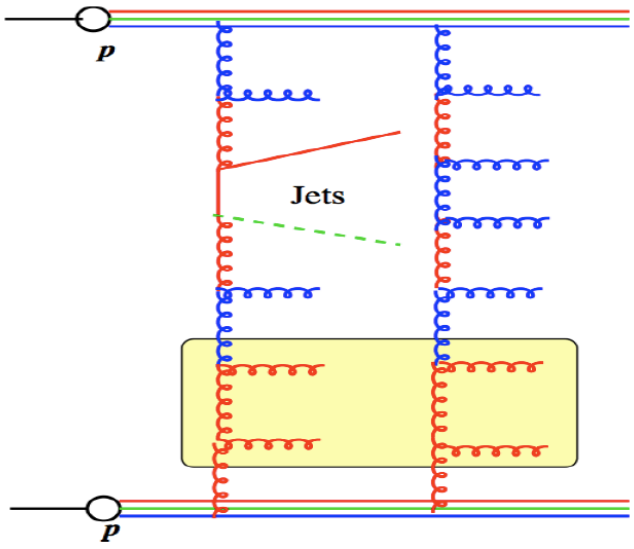
Forward Energy Flow – CMS PAS FWD10-011

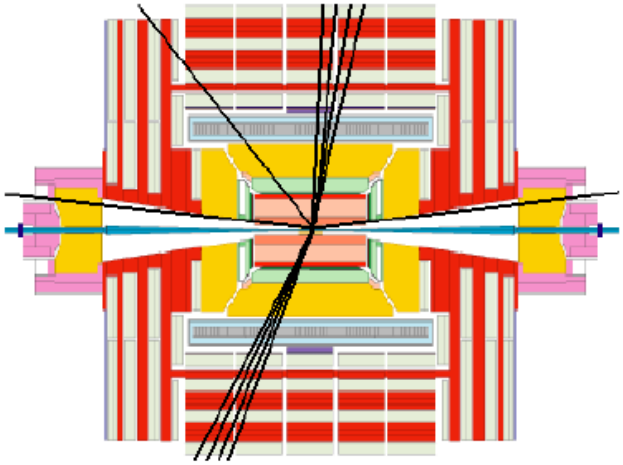
Energy flow

- Measurement of $\frac{1}{N}\frac{dE}{d\eta}$
- Trigger charged particles in forward/backward region ($3.9 < |\eta| < 4.4$)

Jet Selection

- Anti-k_T jets with $R = 0.5$
- $p_T > 8/20$ GeV for 900 GeV/7 TeV
- Two jets back-to-back in $|\eta| < 2.5$

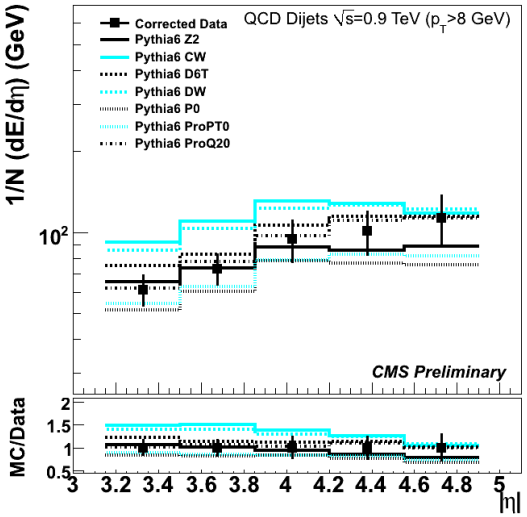


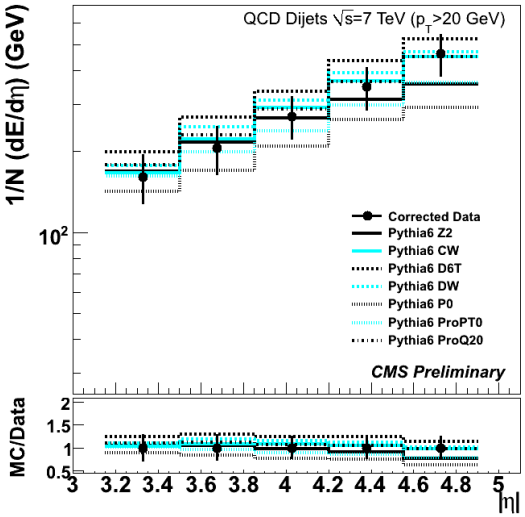


Forward Energy Flow in Di-jet Events

Systematic effects

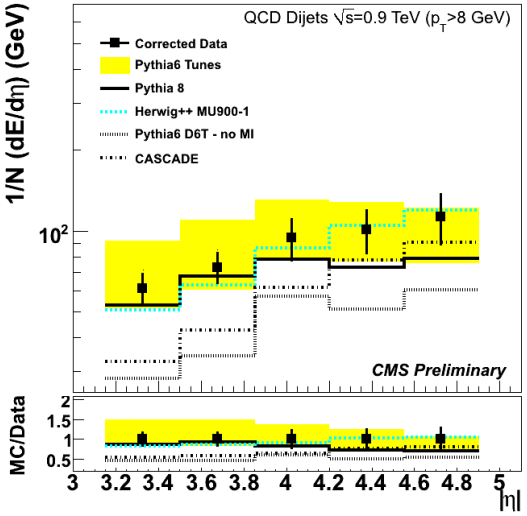
- Energy scale (10%)
- Model dependence (4%-18%)
- Overall (13%-22%)

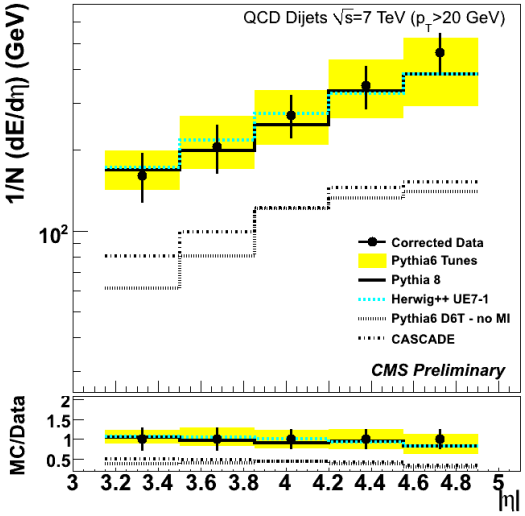




Results

- No MPI fails
- PYTHIA encapsulates data
- HERWIG $\sqrt{s}$-dependent tunes work





Summary

Inclusive forward jet cross section

- Forward calorimeter jets using the anti-k_T considered; largest uncertainty is the jet energy scale
- Measurement in good agreement with theoretical predictions

Simultaneous production of forward and central jets

- Selection comparable; similar systematic effects
- Measurement in reasonable agreement with theoretical predictions

Forward energy flow in di-jet events

- Description is a challenge for event generators with multi-parton interaction models

Conclusion

- Interesting region of phase space; Not been fully investigated before