Forward–Central Jet Correlations in *pp* Collisions at CMS

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CMS PAS FSQ-12-008
`http://cms-physics.web.cern.ch/cms-physics/public/FSQ-12-008-pas.pdf`

Forward–Central Jet Correlations

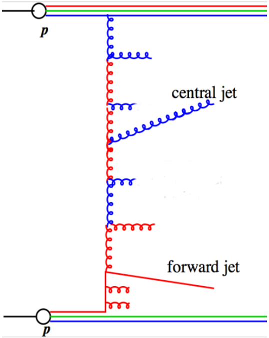


Figure: Feynman diagram for central–forward jet production

- Forward–Central Jet Correlations
  - Probe simultaneously the high and low–x regions / quark and gluon–ladders
- Large η difference between jets
  - Open up phase space for higher-order emissions $\rightarrow$ high sensitivity to QCD and parton dynamics
- Azimuthal correlations ($\Delta\phi$)
  - Study evolution of $\Delta\phi$ correlations as function of rapidity separation of jets
  - DGLAP: stronger correlations
  - BFKL: weaker correlations
- The study of an extra jet inside or outside helps to understand the parton ladder
- Sensitivity to underlying event and multi-parton interactions

Physics Selection

Data

- 3.2 pb^{-1} from 2010 low pile-up *pp* collisions at $\sqrt{s} = 7$ TeV

Physics selection

- Events with at least one forward ($3.2 < |\eta| < 4.7$) and at least one central ($|\eta| < 2.8$) jet with $p_T > 35$ GeV

Different scenarios

1. Inclusive scenario
2. Inside–jet veto scenario ($p_{T\ inside} < 20$ GeV)
3. Inside–jet tag scenario ($p_{T\ inside} > 20$ GeV)
4. Outside–jet tag scenario ($p_{T\ outside} > 20$ GeV)

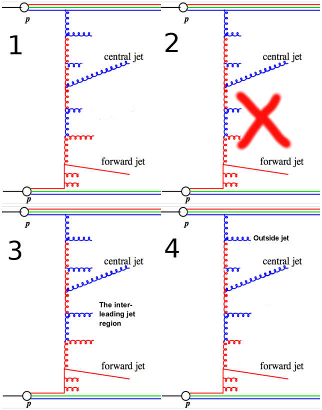
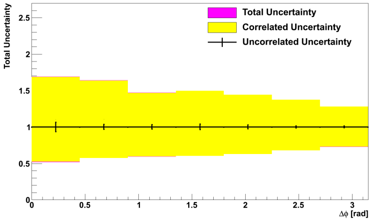


Figure: Diagrams for the different scenarios

Uncertainties

- Correlated Uncertainties
  - Represented as error band
  - **Jet Energy Scale**
  - Luminosity ($\pm 4\%$)
  - Trigger Inefficiency ($+1\%$)
- Uncorrelated Uncertainties
  - Represented as error bar
  - Statistical
  - Model Dependence
  - Pileup Estimation ($\pm$ 1%)



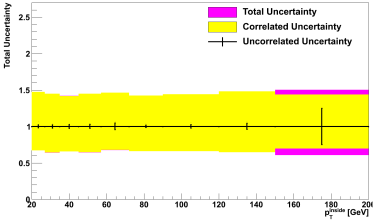
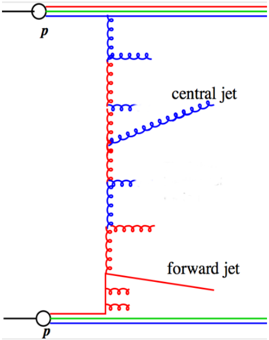


Figure: Total uncertainty for $\Delta\phi$ (up) and p_T^{inside} (down)

Inclusive scenario



Results - $\Delta\phi$ inclusive scenario

- **Data fully corrected to hadron level**
- $\Delta\phi$ is a steeply growing distribution
- All MC models describe the distribution reasonably well, except for the lower $\Delta\phi$ region
- HERWIG++ has the best overall description
- PYTHIA 6 - Z2* without MPI deviates more from data than other PYTHIA 6 tunes

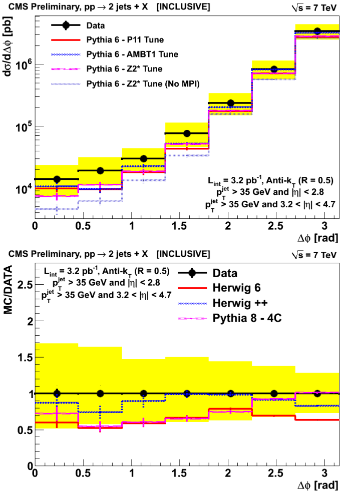
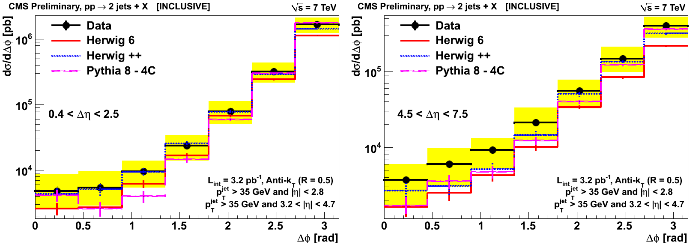


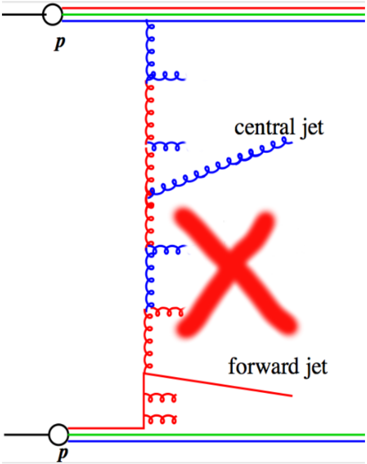
Figure: $\Delta\phi$ in inclusive scenario compared with different MCs

Results - $\Delta\phi$ inclusive scenario in slices of $\Delta\eta$



- At large $\Delta\eta$ there is more phase space for additional radiation
- At small $\Delta\eta$ the distribution is falling much more steeply than at large rapidity separation (from 2 to 2.5 orders of magnitude)
- In general the MC describe this effect, except for the lower $\Delta\phi$ region
- HERWIG++ provides the best overall description
- PYTHIA 6 - Z2* without MPI deviates event more from data than other PYTHIA 6 tunes for the lower $\Delta\phi$ region

Inside–jet veto scenario



Results - $\Delta\phi$ inside–jet veto scenario

- The correlation is stronger than in the inclusive scenario
- PYTHIA deviates more from data in the inclusive scenario while HERWIG describes it better for lower $\Delta\phi$
- The best description is provided by HERWIG++
- PYTHIA 6 - Z2* without MPI deviates from both data and other tunes for lower $\Delta\phi$, having too strong correlation

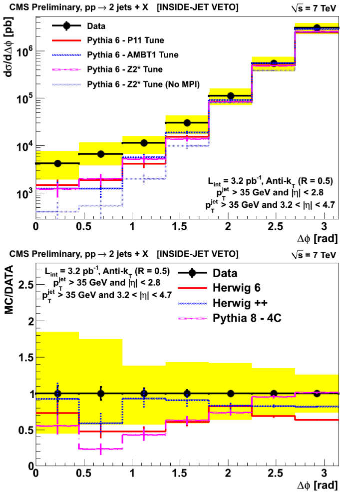
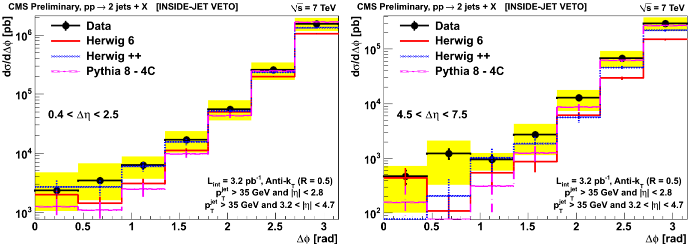


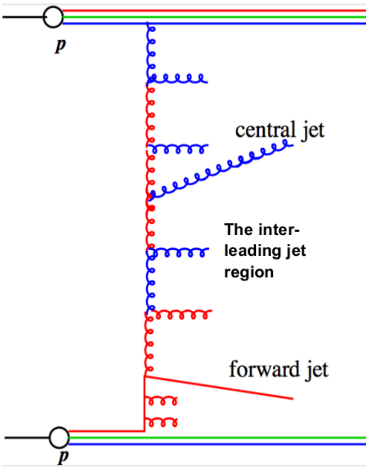
Figure: $\Delta\phi$ in inside–jet veto scenario compared with MC predictions

Results - $\Delta\phi$ inside–jet veto scenario in slices of $\Delta\eta$



- In the inside–jet veto scenario, the slopes are steeper (3 orders of magnitude)
- The correlation shape has no significant variation with $\Delta\eta$
- HERWIG++ gives the best description
- For lower $\Delta\phi$ region PYTHIA 6 - Z2* without MPI is one order of magnitude away from the data

Inside–jet tag scenario



Results - Leading inter-leading jet p_T

- The MC models describe the data reasonably well at low p_T
- PYTHIA 6 - Z2* without MPI shows a deficit for the lower p_T region
- PYTHIA 6 - P11 provides the best prediction

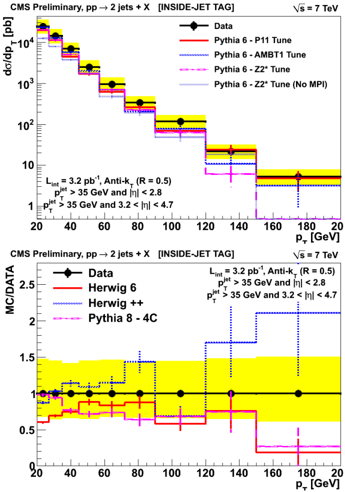


Figure: Leading inter-leading jet p_T compared with MC predictions

Results - $\Delta\phi$ inside–jet tag scenario

- The correlation is weaker than in the inclusive scenario
- Most predictions seem to yield a reasonable shape but fail slightly in the normalization
- The best description is provided by HERWIG++
- PYTHIA 6 - Z2* without MPI predicts a much lower cross-section than observed

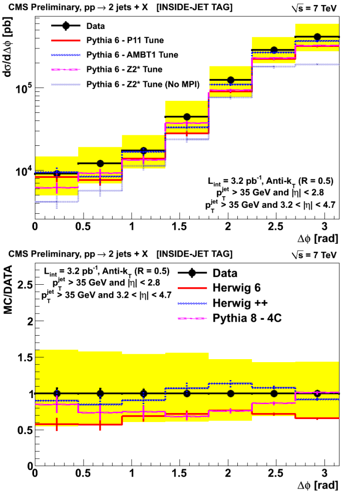
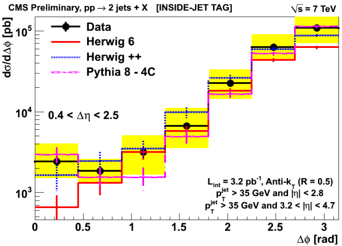


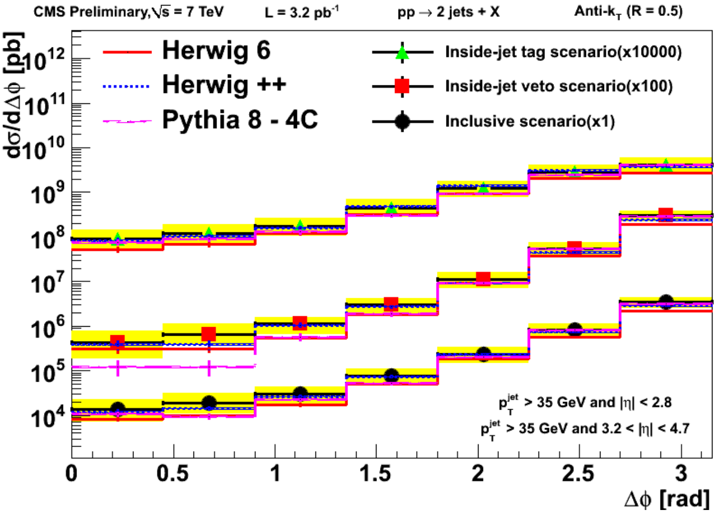
Figure: $\Delta\phi$ in inside–jet tag scenario compared with different MCs

Results - $\Delta\phi$ inside–jet tag scenario in slices of $\Delta\eta$



- The slope decreases as function of $\Delta\eta$ (2 to 1.5 orders of magnitude)
- The correlation is much weaker that in the inside–jet veto scenario
- HERWIG++ yields the best description
- PYTHIA 6 - Z2* without MPI fails both in slope and normalization

Scenarios Comparison



Summary

- For the first time azimuthal correlations are measured in different scenarios, for different rapidity separation, and compared with different Monte Carlo predictions; p_T and η–derived variables are also measured.
- Suprisingly DGLAP MCs describe the observables very well
- BFKL will be added soon
- Overall HERWIG performs better than PYTHIA and the best description in provided by HERWIG++
- PYTHIA 6 - Z2* with MPI decribes the data better than PYTHIA 6 - Z2* without MPI

THANKS FOR YOUR ATTENTION