

Multiple Parton Interactions in PhotoProduction in ep



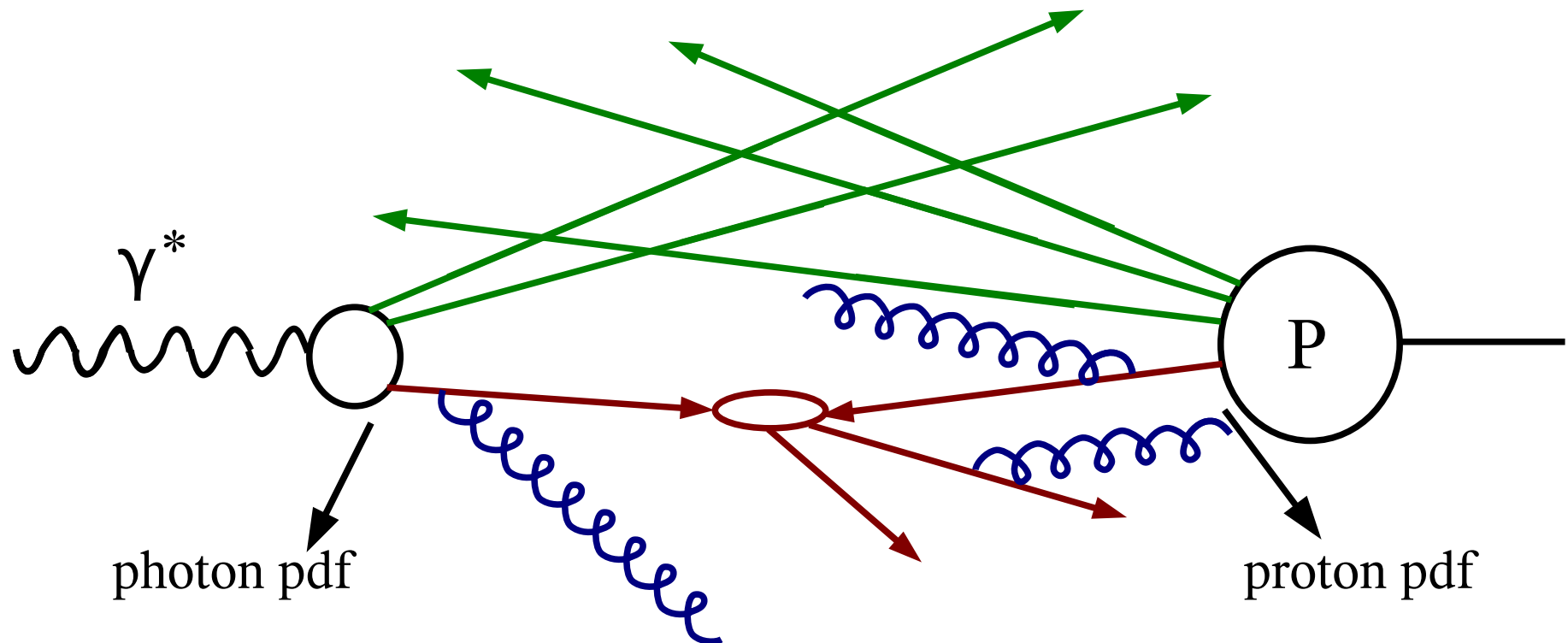
Lluís Martí Magro
(Hannes Jung)

Geneva, HERA-LHC Workshop. 27th of Mai, 2008.

Multiple Parton Interactions in ep collisions

Introduction and Motivation

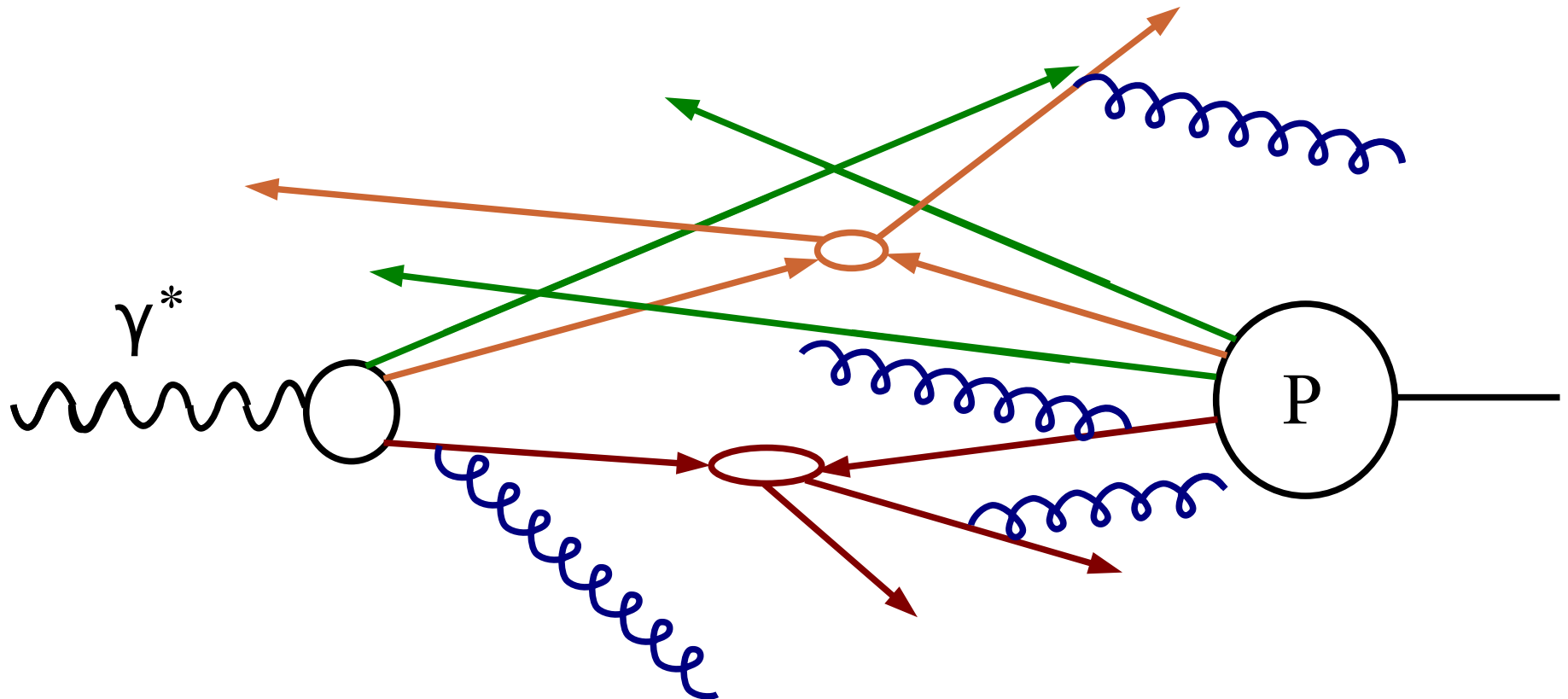
- Photons may develop a hadronic structure.



in this case we also have a photon remnant...

Introduction and Motivation

\times and like in hadron-hadron collisions the remnants may interact



Sample and Observables definition

Sample definition: event selection

Event Selection:

✗ $Q^2 < 0.01 \text{ GeV}^2$ ← we are well in photoproduction

✗ $0.3 < y < 0.65$

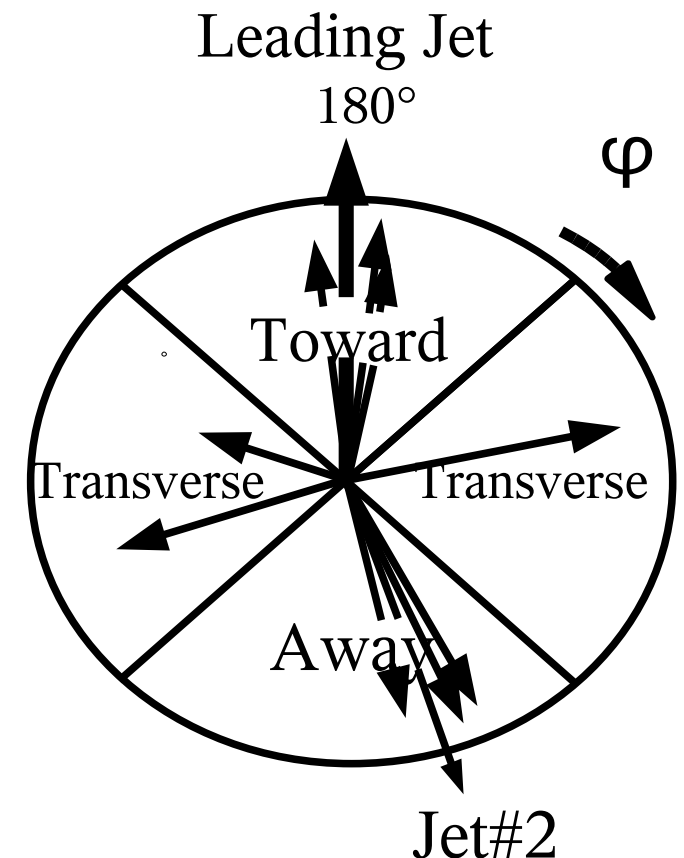
✗ DiJet sample: $P_t^{\text{Jet}} > 5(5) \text{ GeV}$

$-1.5 < \eta^{\text{Jets}} < 1.5$

no cut in $\Delta\varphi^{\text{Jets}}$

✗ Cuts on tracks:

✗ with $P_t > 150 \text{ MeV}$ and $|\eta| < 1.5$



Sample definition: event selection

Event Selection:

✗ $Q^2 < 0.01 \text{ GeV}^2$ ← we are well in photoproduction

✗ $0.3 < y < 0.65$

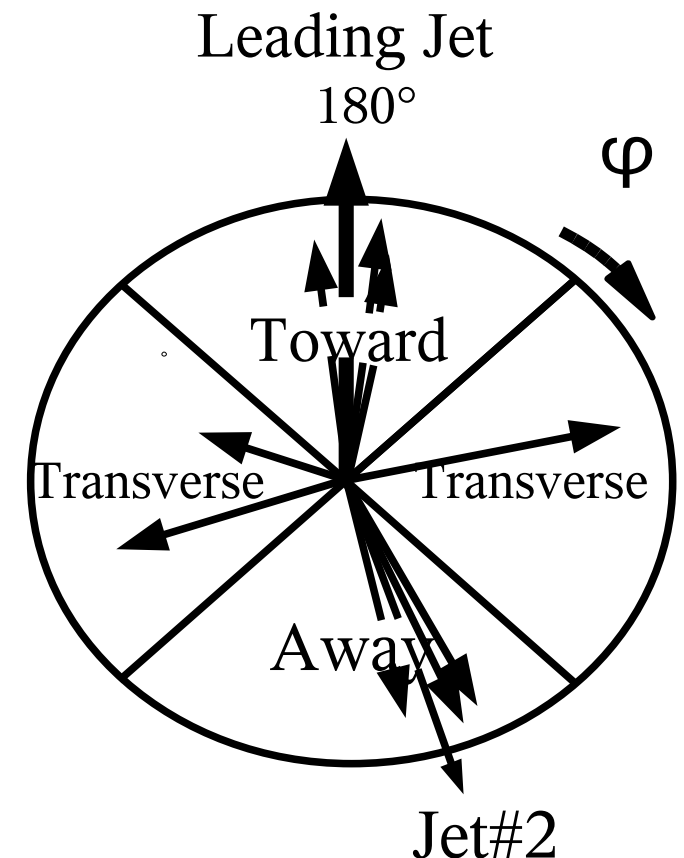
✗ DiJet sample: $P_t^{\text{Jet}} > 5(5) \text{ GeV}$

$-1.5 < \eta^{\text{Jets}} < 1.5$

no cut in $\Delta\varphi^{\text{Jets}}$

✗ Cuts on tracks:

✗ with $P_t > 150 \text{ MeV}$ and $|\eta| < 1.5$



No data points preliminary yet but expected before summer

Observable definition

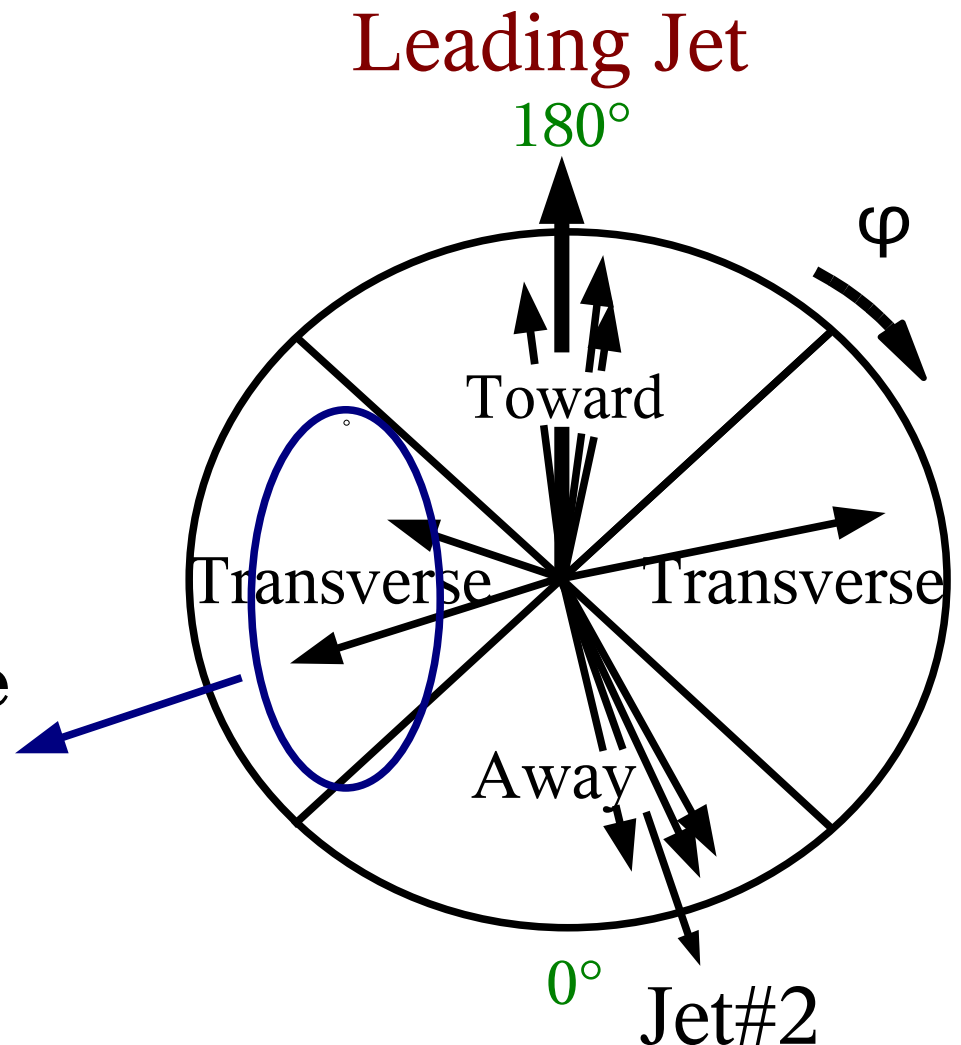
- ✗ Observable: track multiplicity as a function of $\Delta\varphi$ and P_t^{Jet} in bins of X_γ .

We define three regions:

- ✗ Toward: $120^\circ < \varphi < 240^\circ$
- ✗ Transverse: $60^\circ < \varphi < 120^\circ$
 $240^\circ < \varphi < 300^\circ$
- ✗ Away: $300^\circ < \varphi < 60^\circ$

The high activity region is the transverse region hemisphere

with higher $P_t^{\text{sum}} = \sum_i^{\text{tracks}} p_t^i$



Monte Carlo

x Monte Carlo (Pythia) model:

no impact parameter, no interleaved parton showers, abrupt P_t^{\min} cut

x Four sets of MC:

“MC”: Monte Carlo tuned to Data

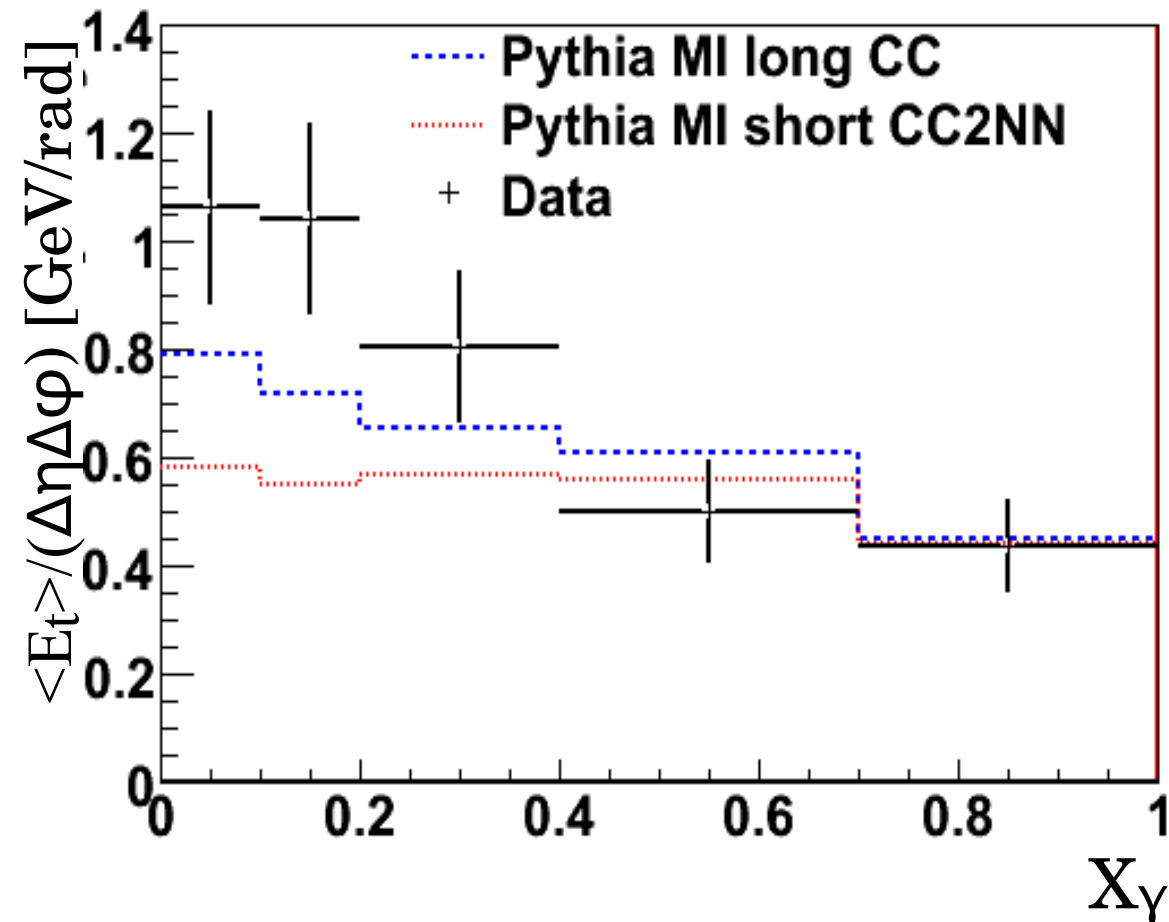
“Pythia NMI” Default but without MPI

“MI short CC2NN”: Default but PARP (85) & PARP (86) changed

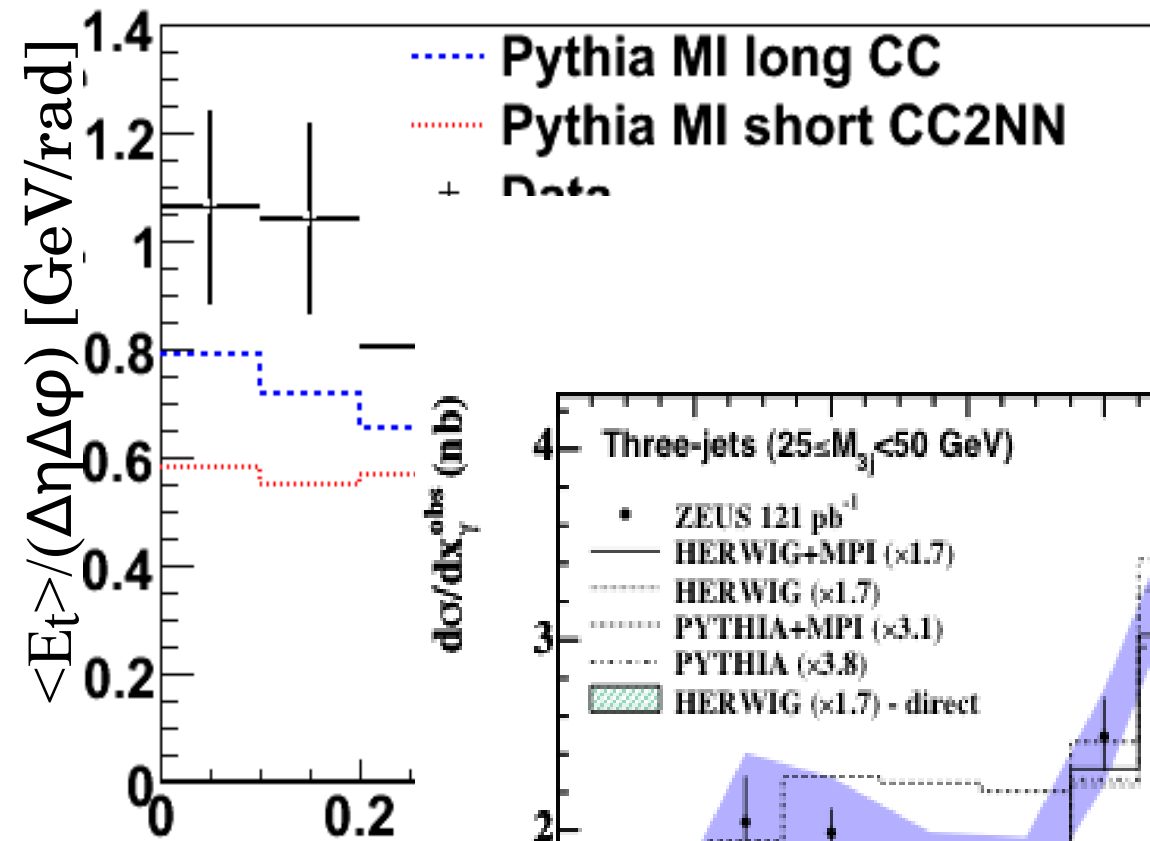
“MI long CC”: Default but PARP (85) = 0.33

Previous measurements at HERA

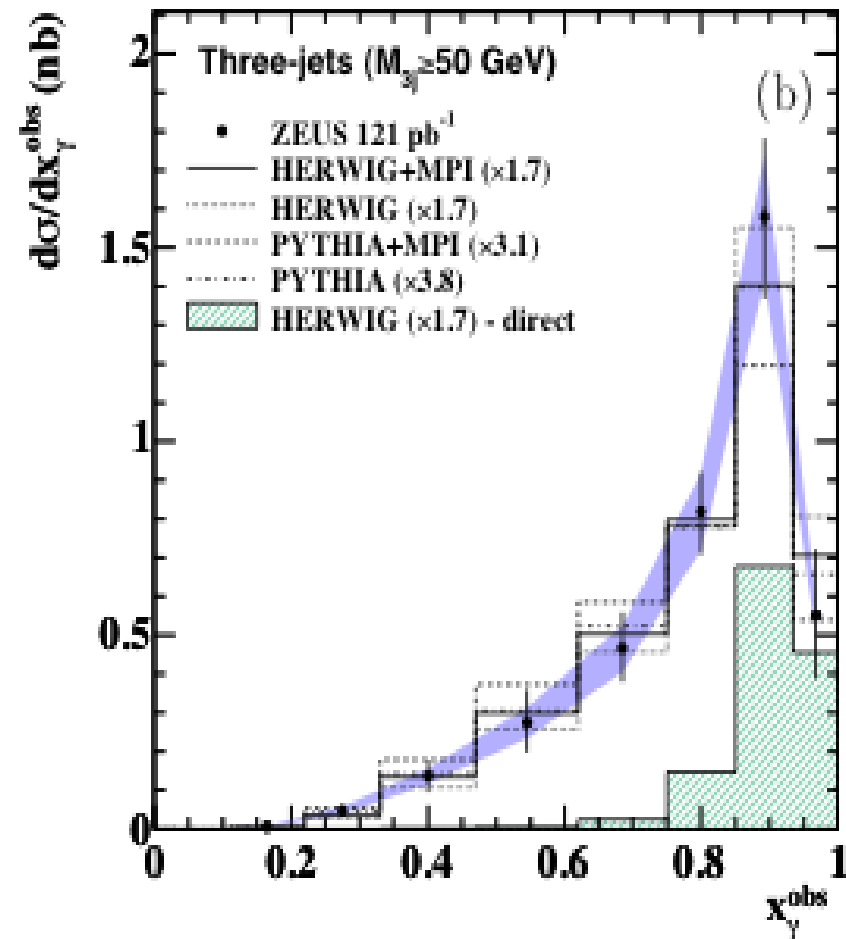
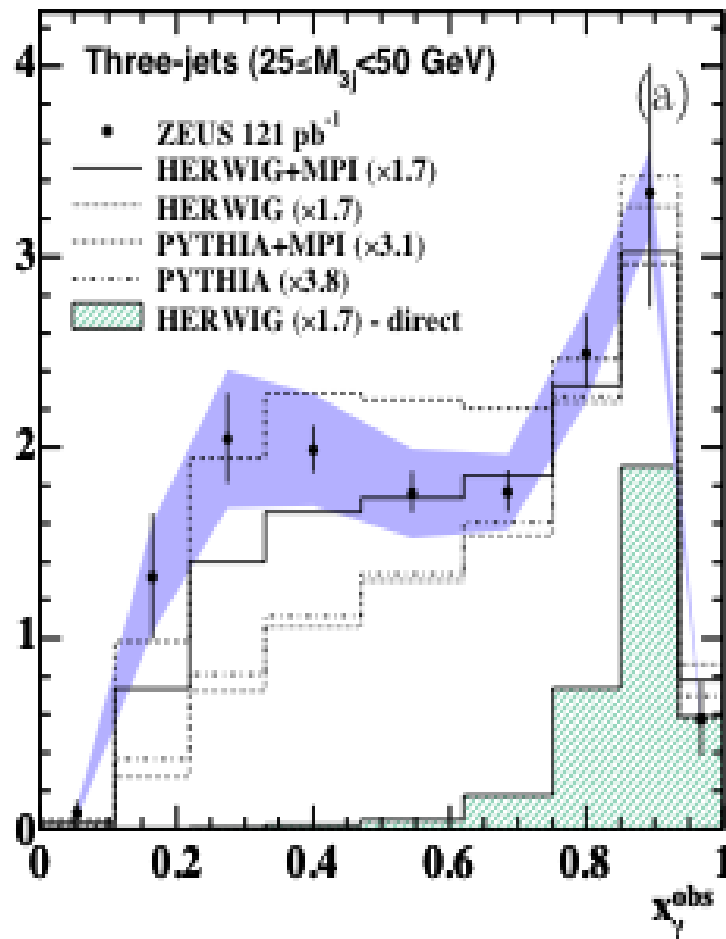
Multiple Parton Interactions (MPI)



Multiple Parton Interactions (MPI)



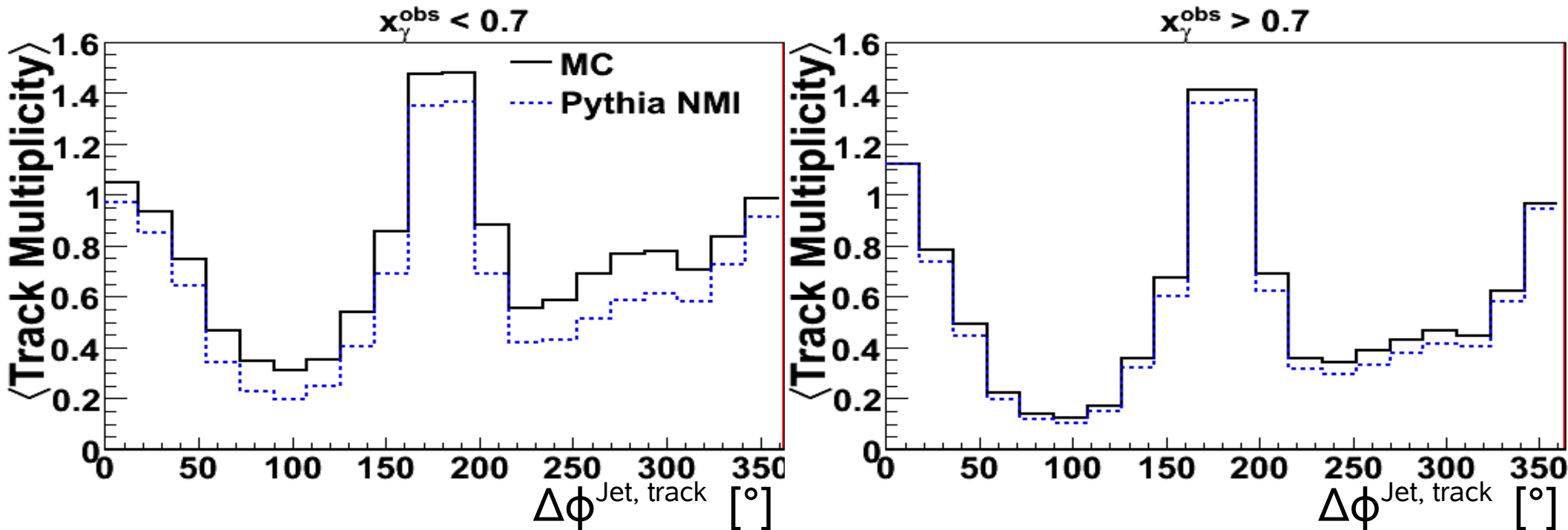
ZEUS



Charged Particles Multiplicities Correlation Studies

Multiple Parton Interactions (MPI)

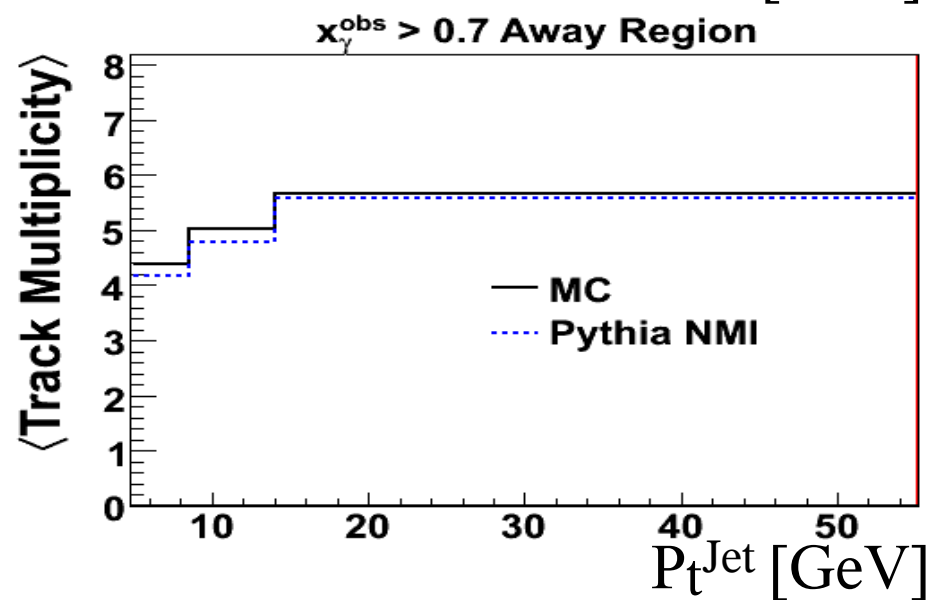
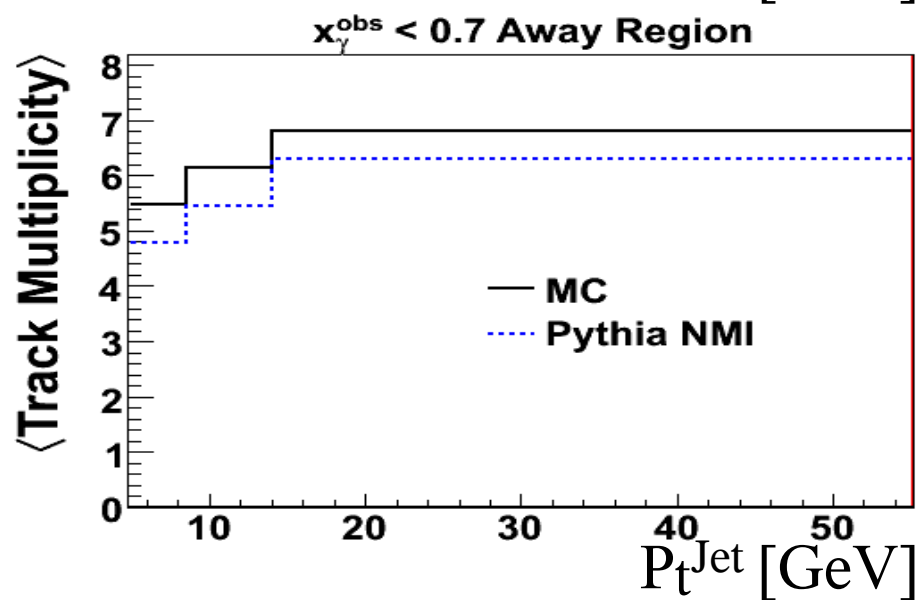
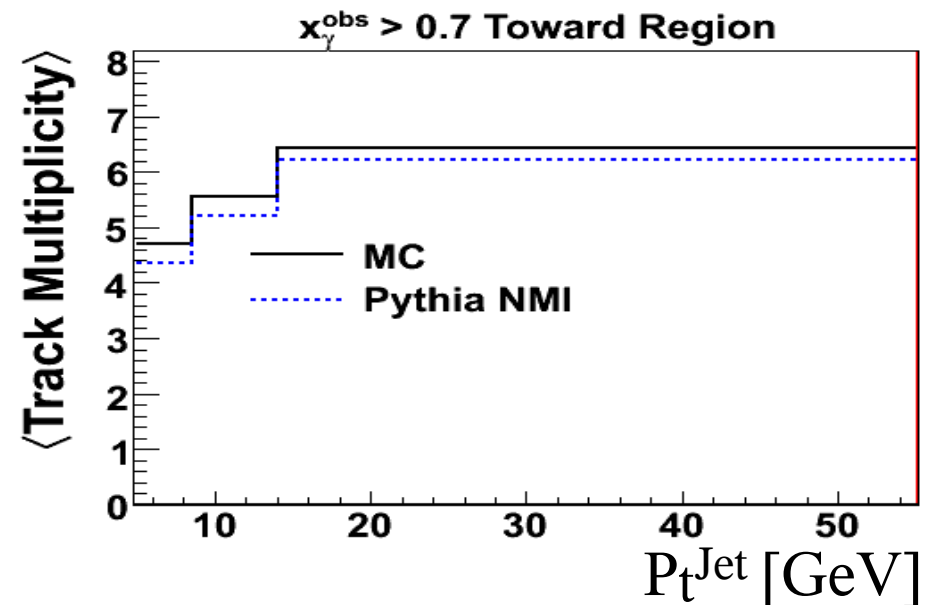
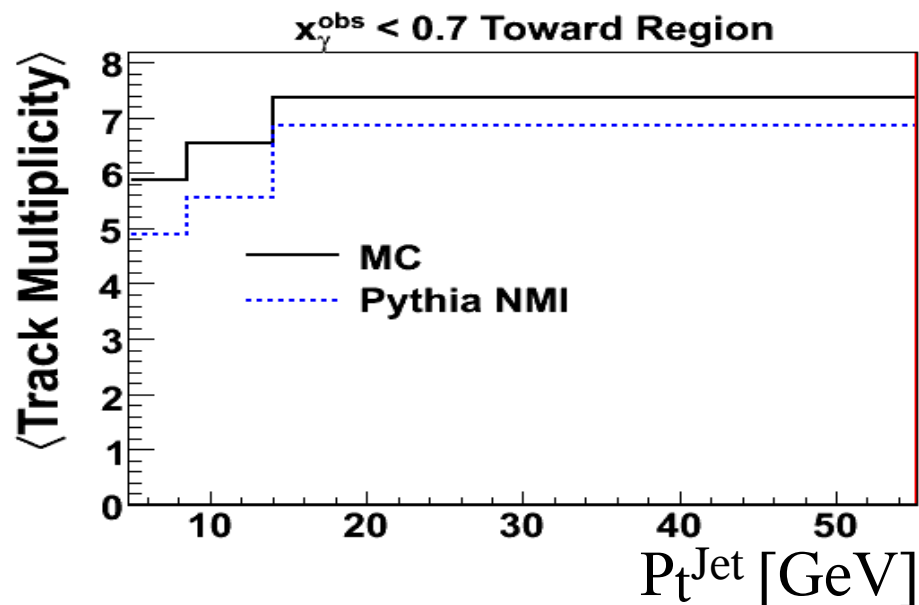
Compare: MC vs Pythia NMI in X_γ bins



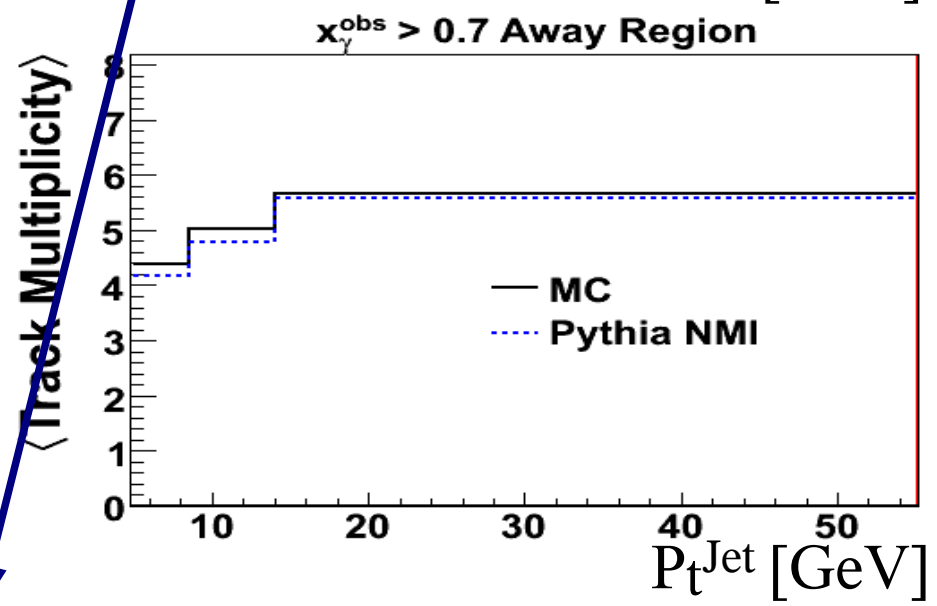
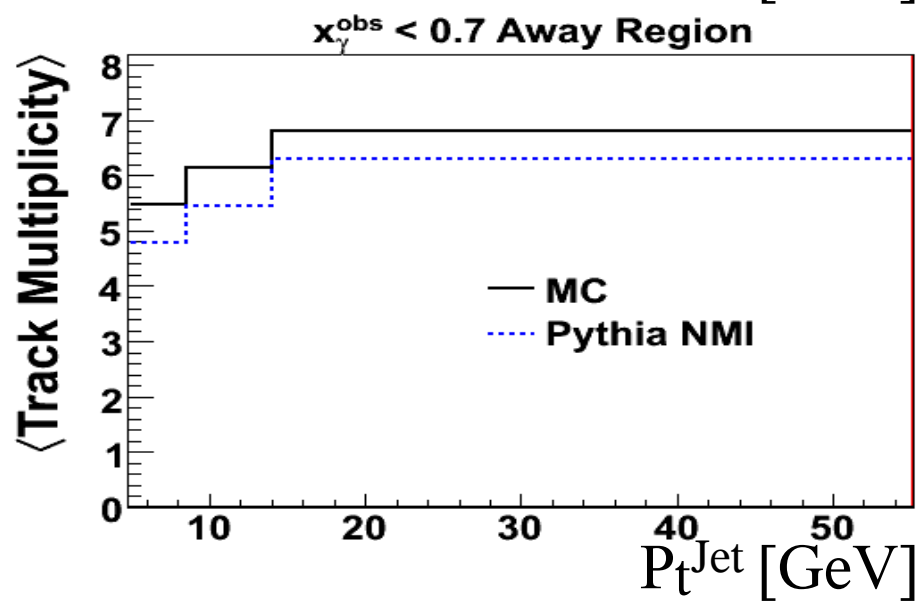
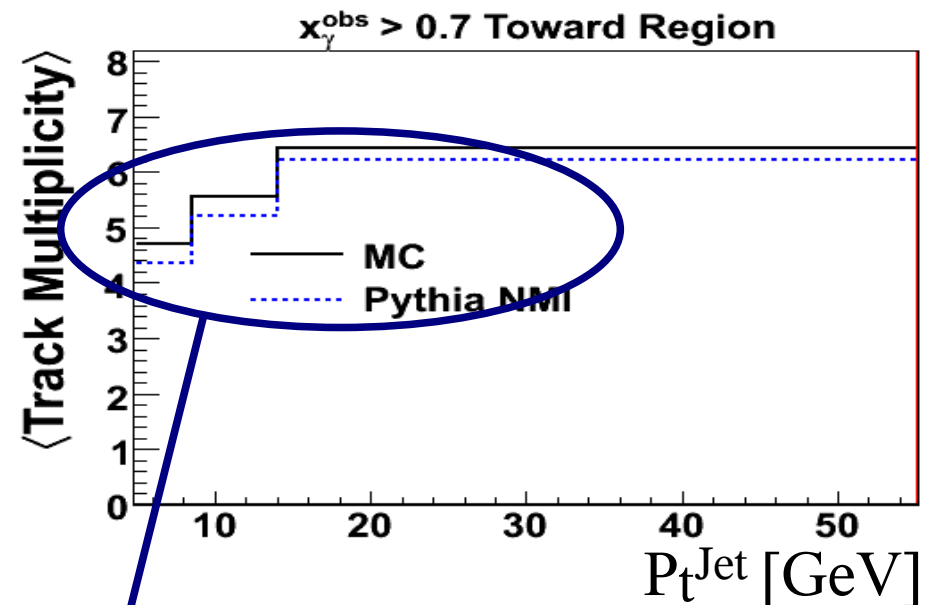
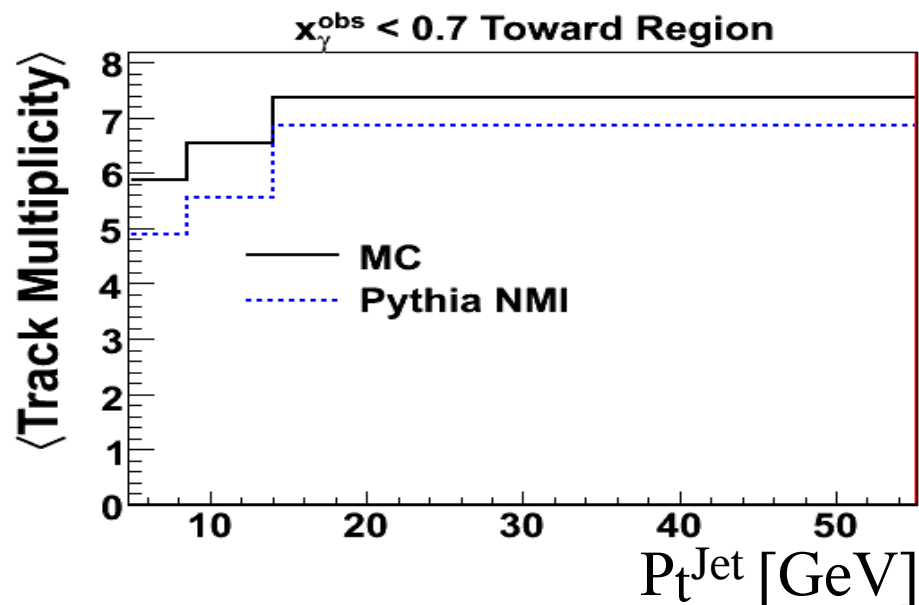
MC comes closest to not yet released data.

At low X_γ it looks like we just need some more particles...

Multiple Parton Interactions (MPI)

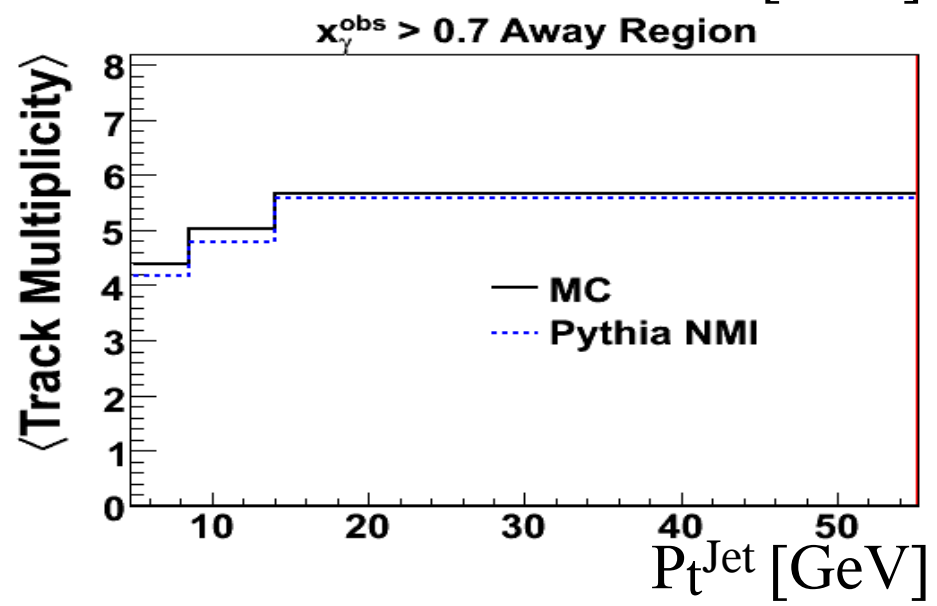
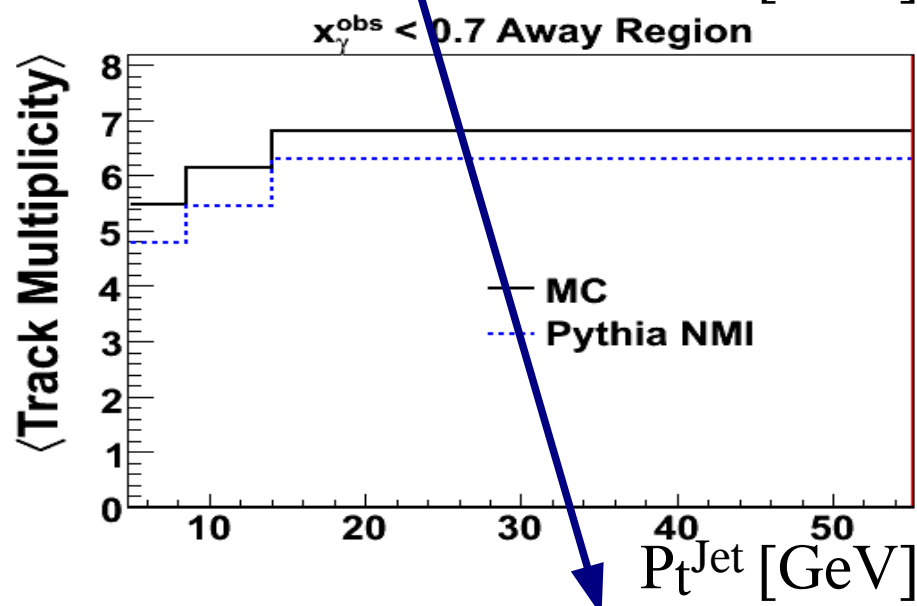
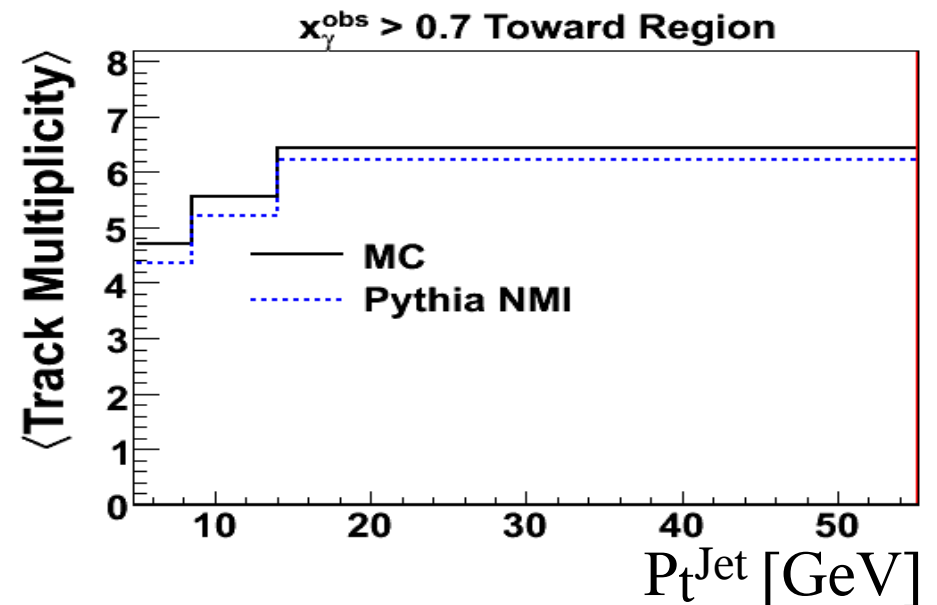
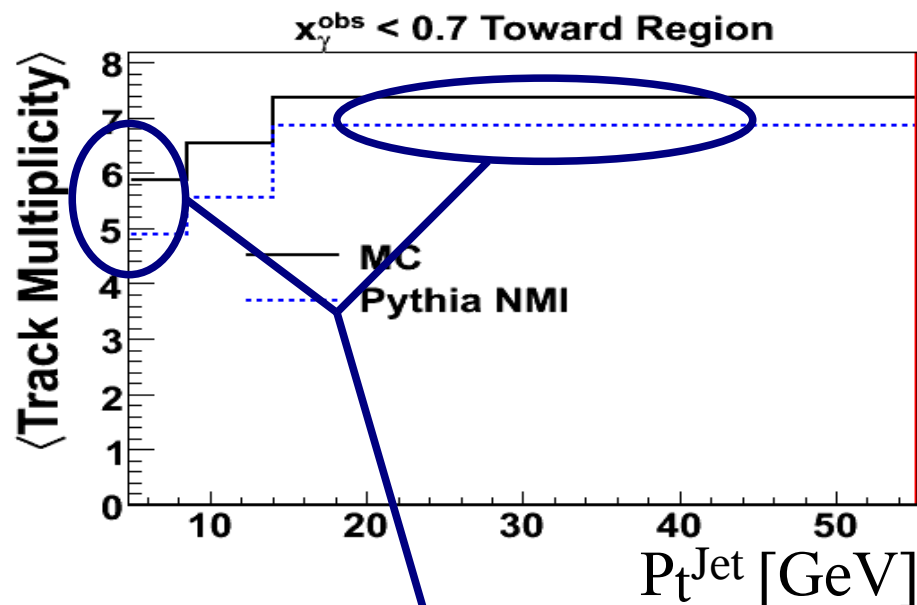


Multiple Parton Interactions (MPI)



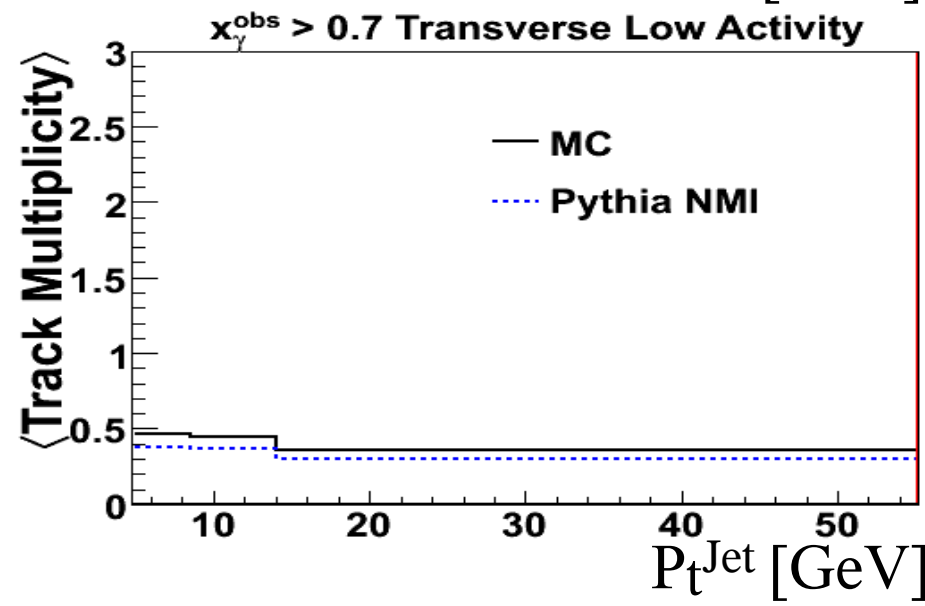
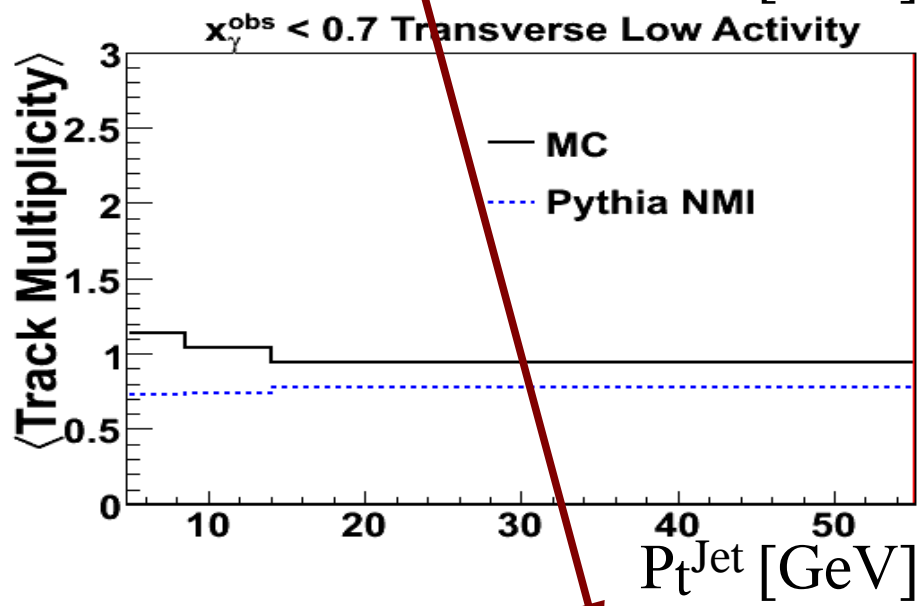
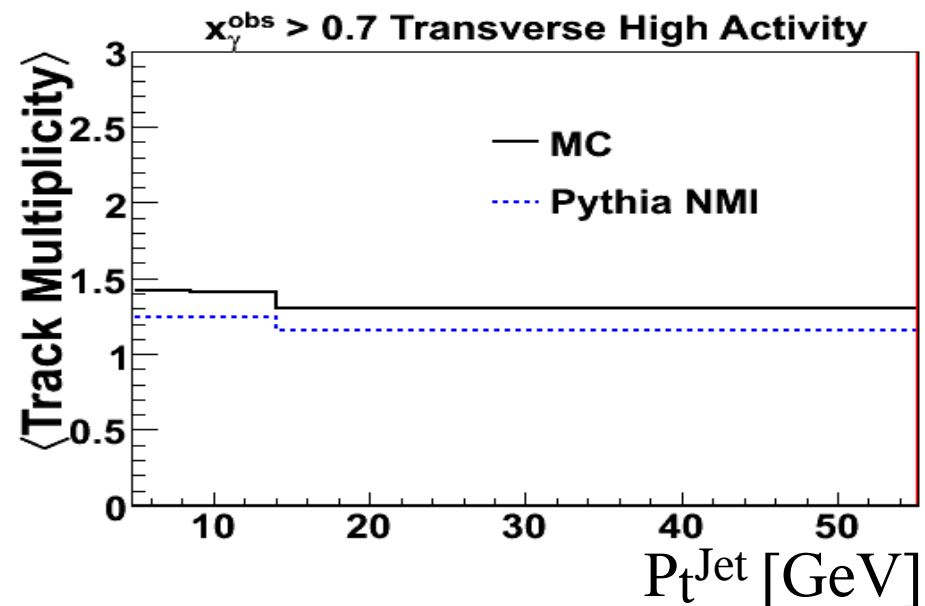
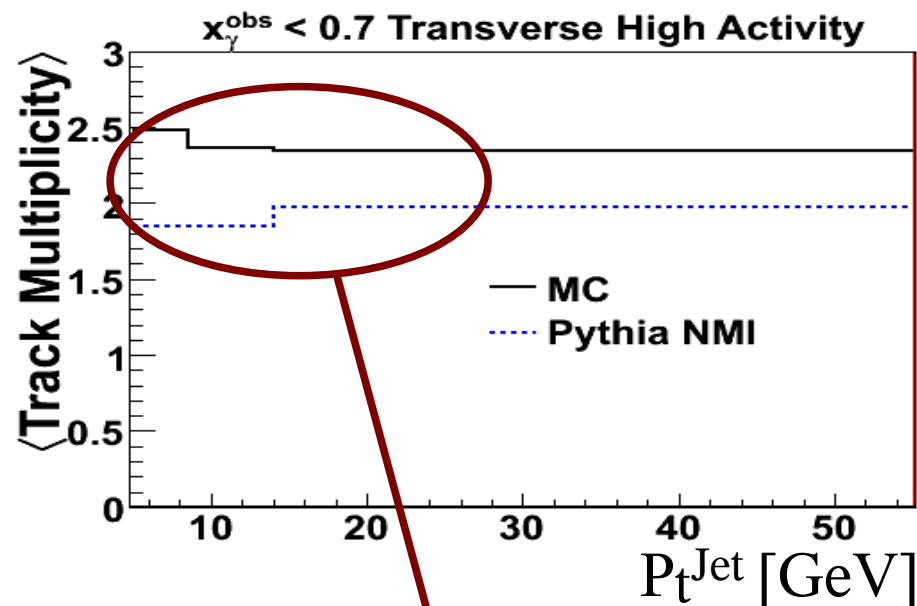
Small discrepancy at high X_γ

Multiple Parton Interactions (MPI)



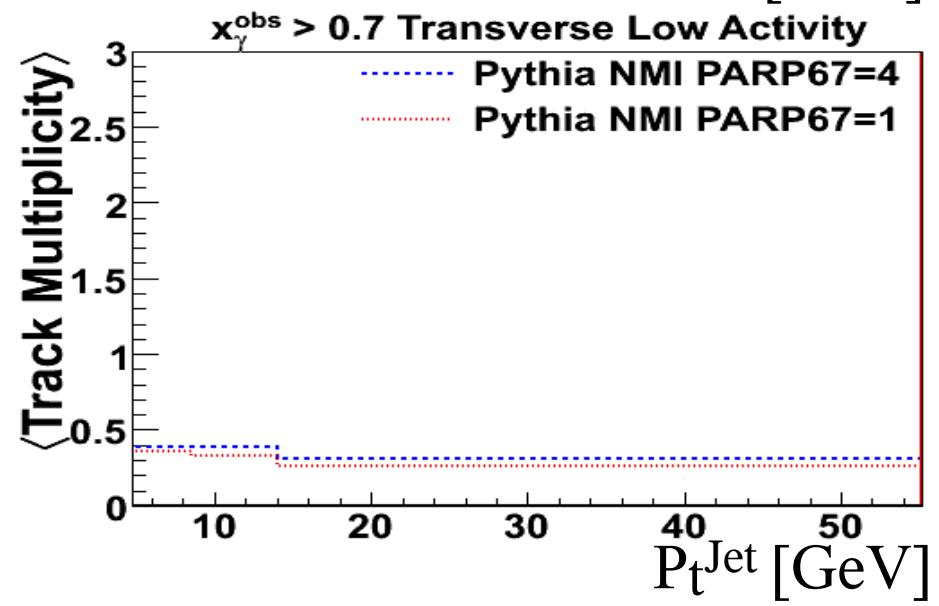
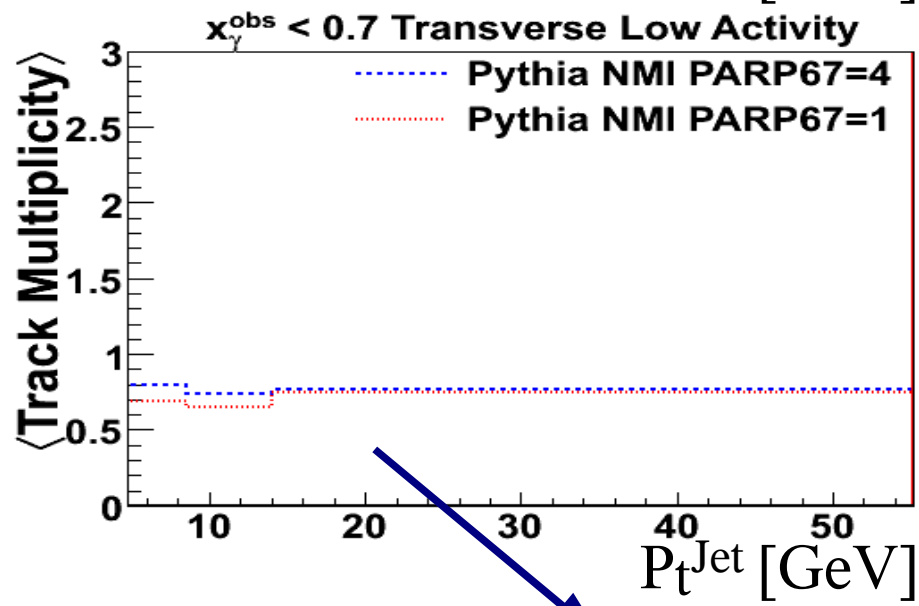
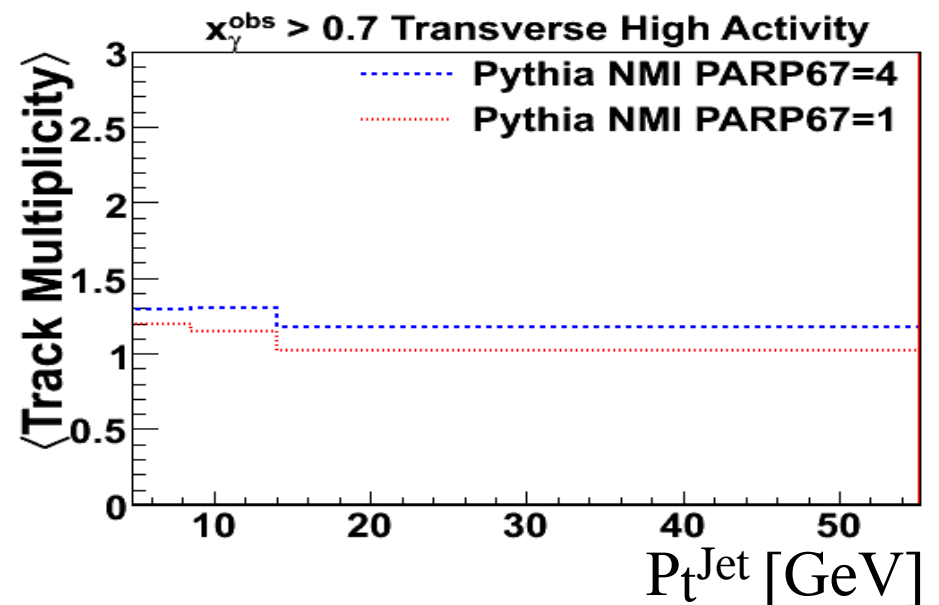
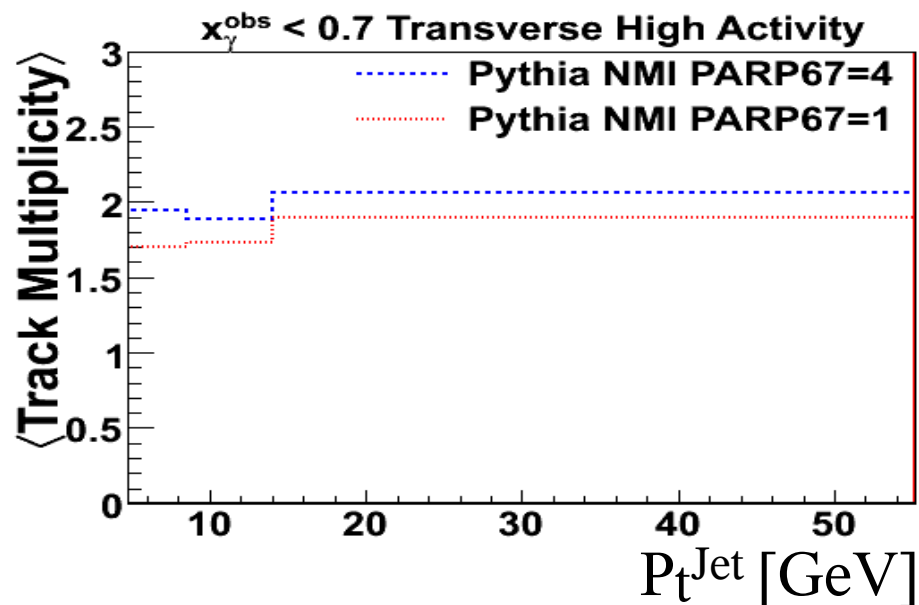
At high P_t^{Jet} the discrepancy decreases

Multiple Parton Interactions (MPI)



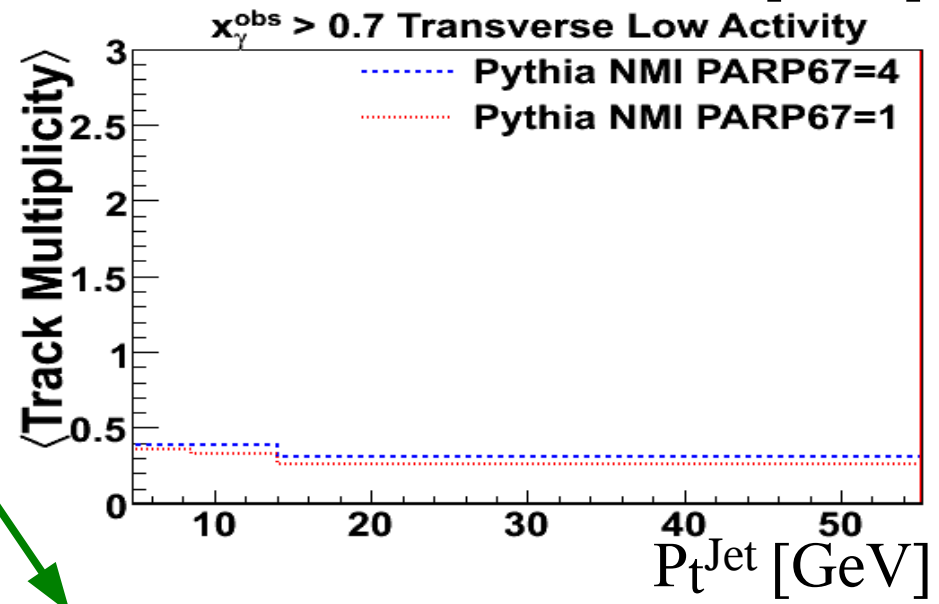
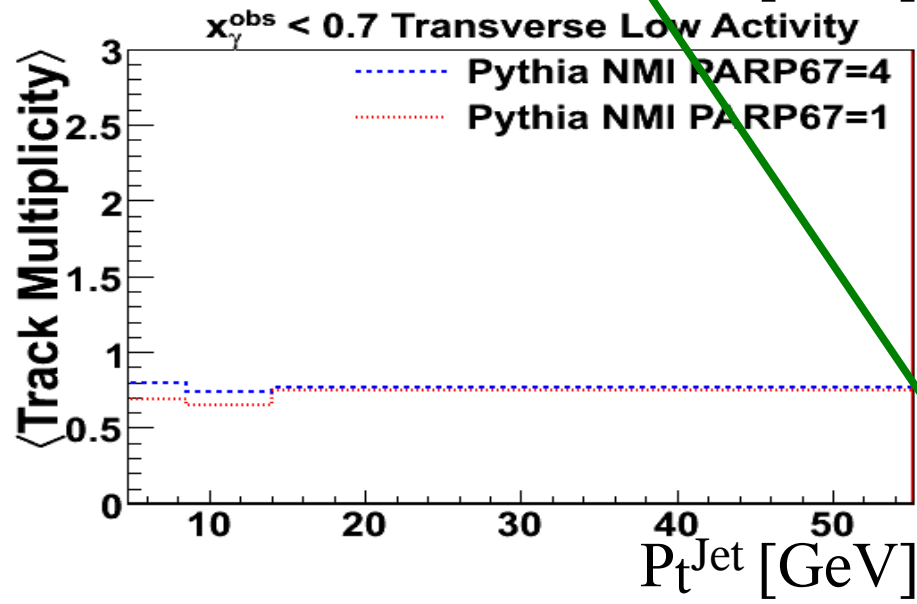
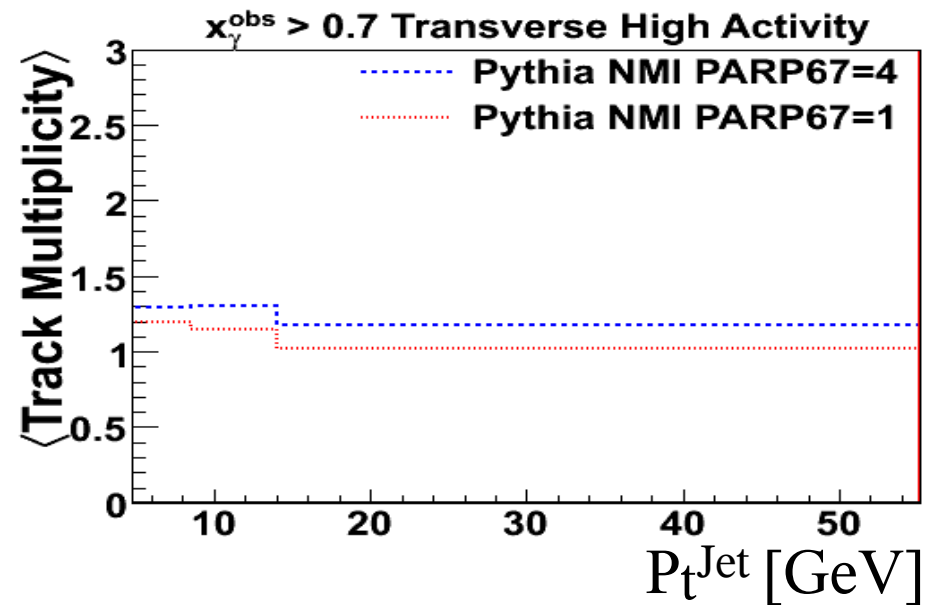
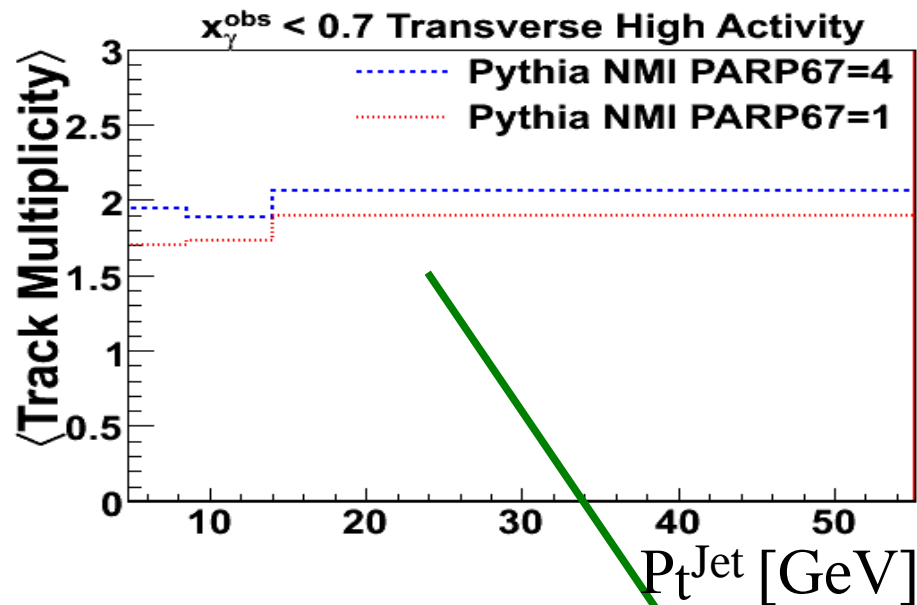
Large effect in the transverse high activity region

Multiple Parton Interactions (MPI)



rather insensitive to ISR

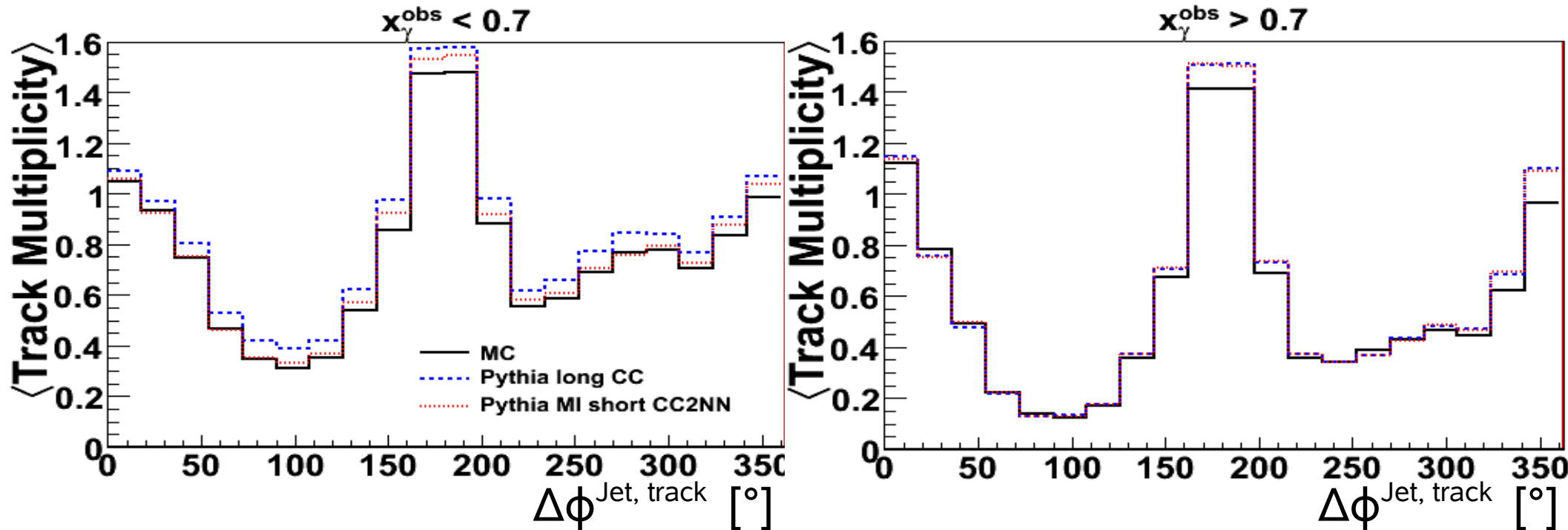
Multiple Parton Interactions (MPI)



ISR has a larger contribution in the high activity region

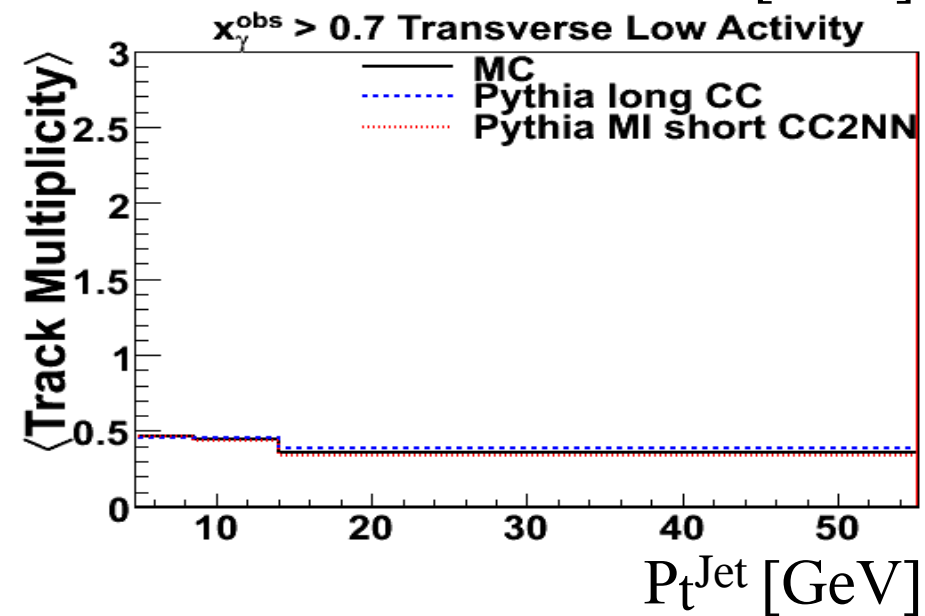
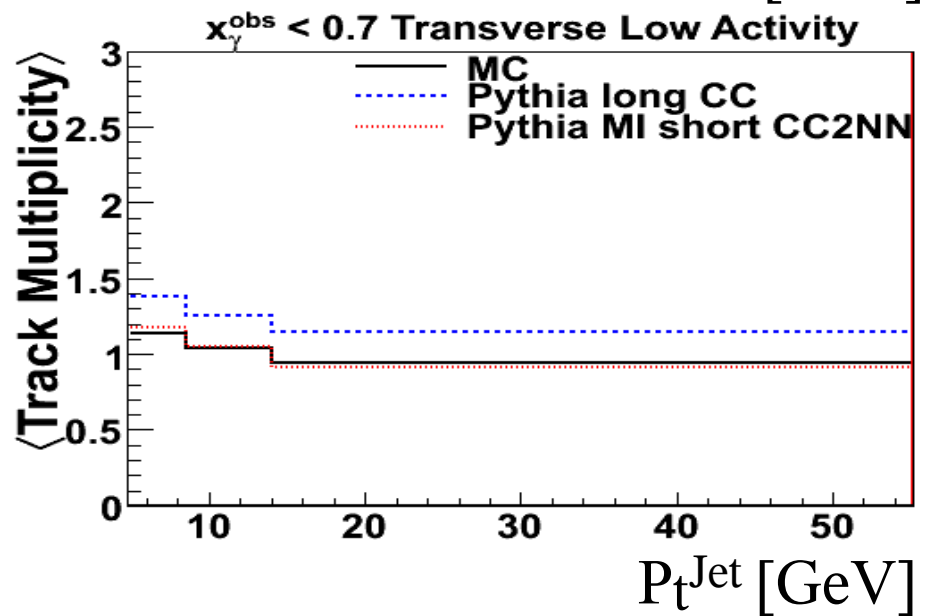
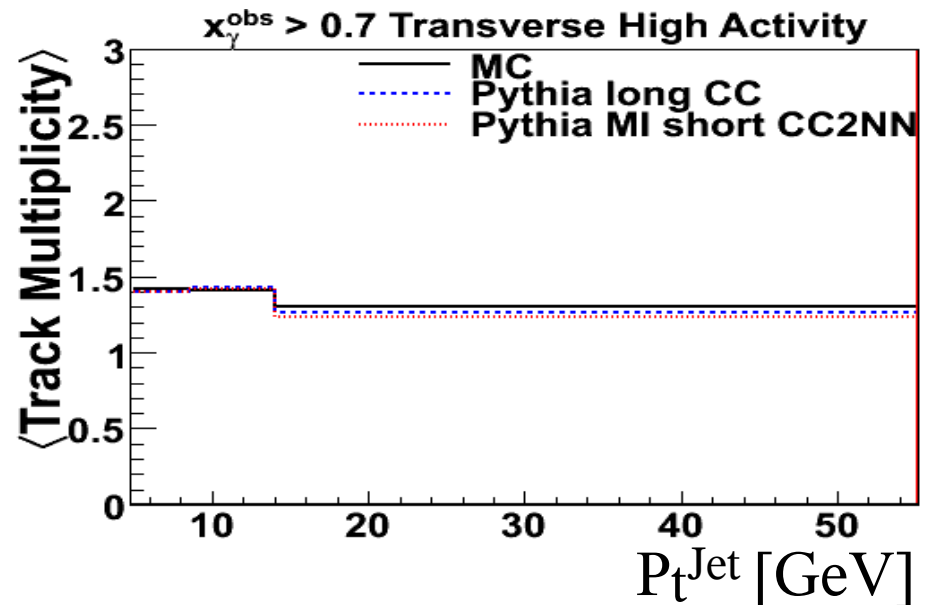
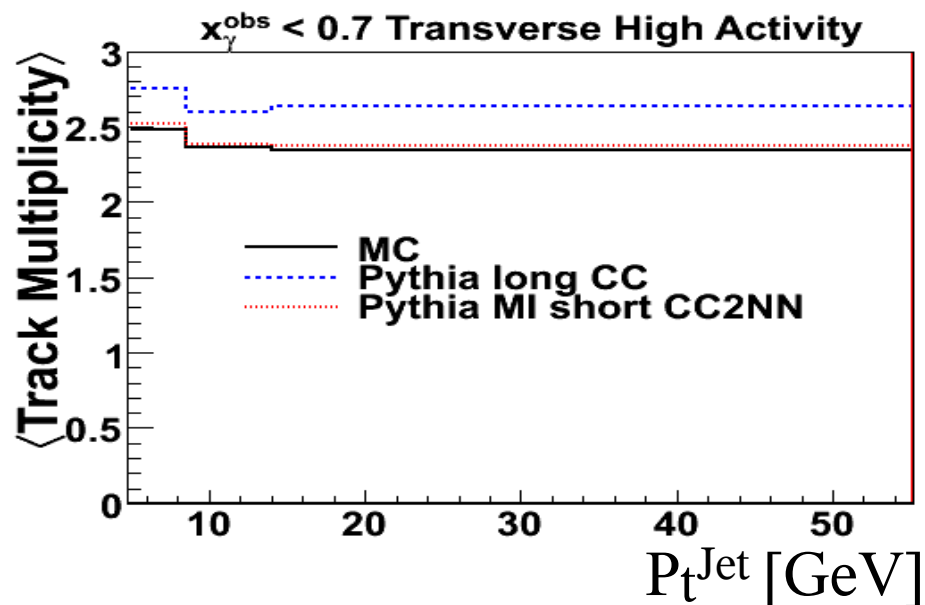
Multiple Parton Interactions (MPI)

Compare different parameters in X_γ bins



As expected at low X_γ having longer strings gives higher track multiplicity.

Multiple Parton Interactions (MPI)



Summary

- ✗ At HERA we can study MPI as a function of X_Y
- ✗ Kinematic effects are seen as a function of P_t^{Jet}
 - ✗ MPI also present in the Toward and Away regions.
 - ✗ **Transverse High** activity region:
 - ✗ has a large contribution from MPI.
 - ✗ sensitive to ISR
 - ✗ **Transverse Low** activity region:
 - ✗ also with a large contribution of MPI but decreasing with P_t^{Jet} due to kinematic effects.
 - ✗ rather insensitive to ISR
- ✗ The transverse region is sensitive to different MPI models and short strings seem to be preferred.

Summary and Outlook

Outlook

- x Have the data preliminary for the proceedings this summer and use it to tune MC for γ -p.
- x

Thank you for your attention