

Underlying-event Activity Studies in p+p@200 GeV by STAR



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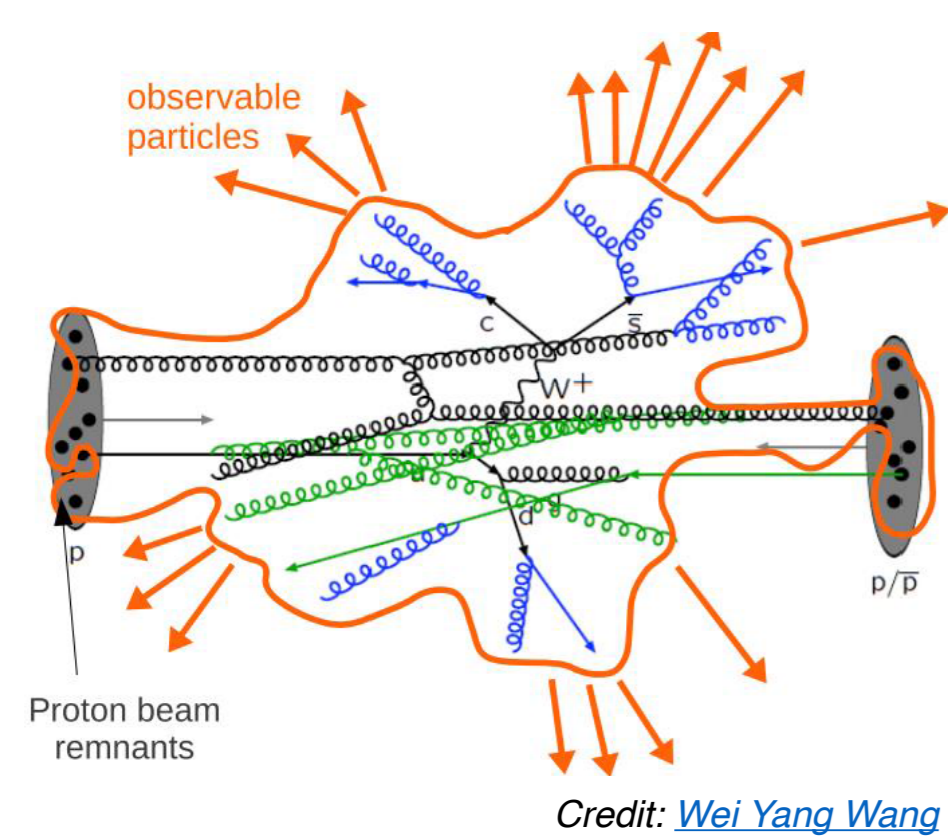
Observations and Conclusions

- Underlying-event activity is measured by particle production in transverse region with respect to the leading jet angle at p+p@200 GeV
- Transverse charged particle multiplicity slightly decreases at higher leading jet p_T**
- PYTHIA perugia 2012 over-predicts transverse charged multiplicity by 25%+/-15% at $15 \text{ GeV}/c < \text{jet } p_T < 45 \text{ GeV}/c$ in p+p@200 GeV
- Indication of less initial and final state radiation (ISR/FSR) at RHIC energies than at LHC energies

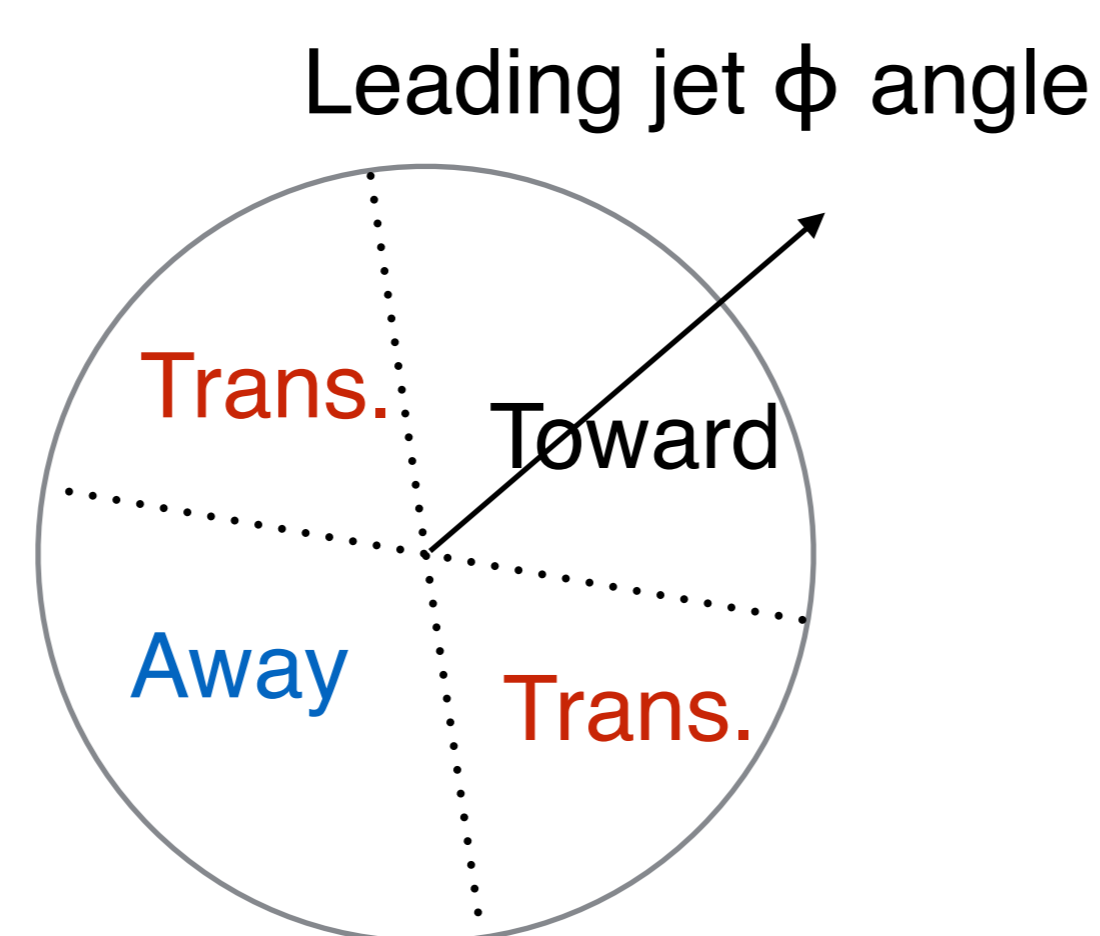
Introduction

Underlying-event activity:

- Particle production not directly from the final fragmentation of hard-scattered partons (gluons/quarks): **ISR/FSR, Multi-Parton interaction, Color reconnection with beam remnants...**
- Tool to study non-factorizable and non-perturbative phenomena



Jet reconstruction:
FastJet* package 3.1.3
anti- k_T algorithm
jet cone $R = 0.6$
jet $|\eta_{jet}| < 0.4$
No background ρ subtraction
charged+neutral constituents
constituent $p_T > 0.2 \text{ GeV}/c$
constituent $|\eta| < 1$



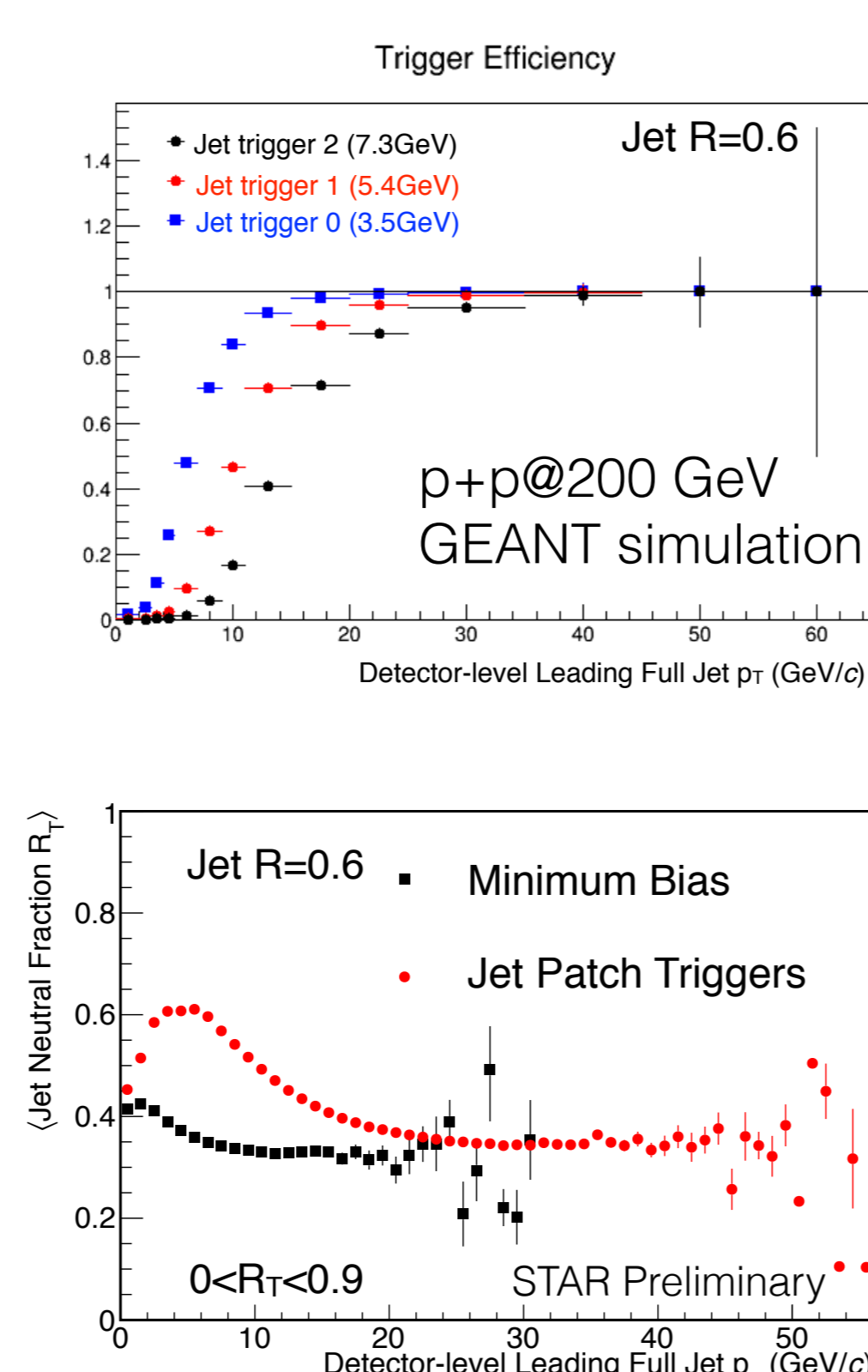
- Divide each event into regions of size 120° defined by their azimuthal angle relative to the leading jet direction
- Underlying event activity is accessed through the **transverse** regions
- Higher multiplicity transverse region is defined as TransMax, and the other TransMin. TransMax has more ISR/FSR contributions

* FastJet package: Cacciari, Salam and Soyez, arXiv:1111.6097

Analysis Method

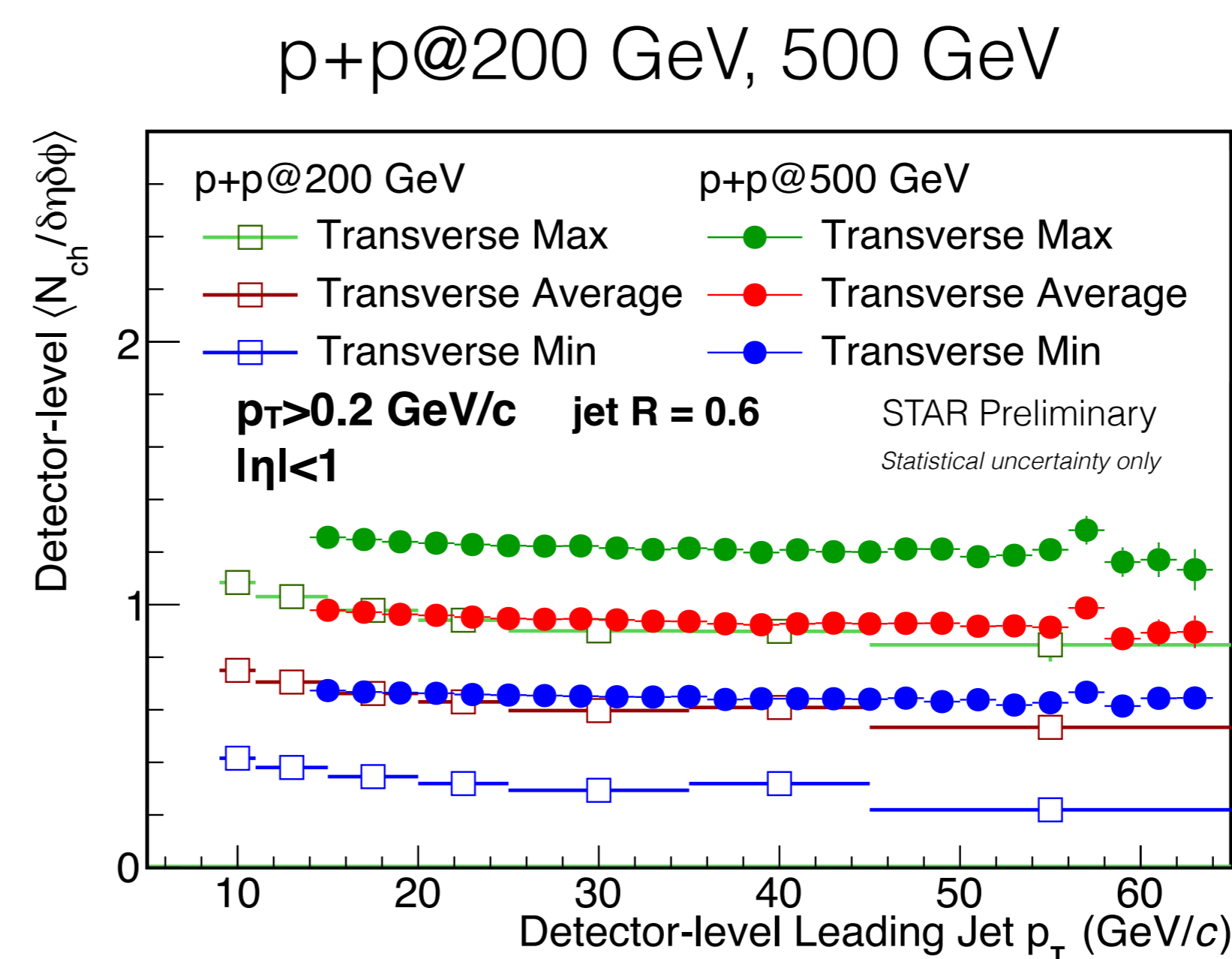
Trigger bias correction:

- Minimum bias (MB) trigger has limited statistics
- Jet patch triggers require neutral energy thresholds to fire
- Data-driven trigger bias corrections are applied by weighting jet triggered events to have the same jet neutral fraction distribution as MB
- Data-driven trigger bias corrections are compared with GEANT simulation

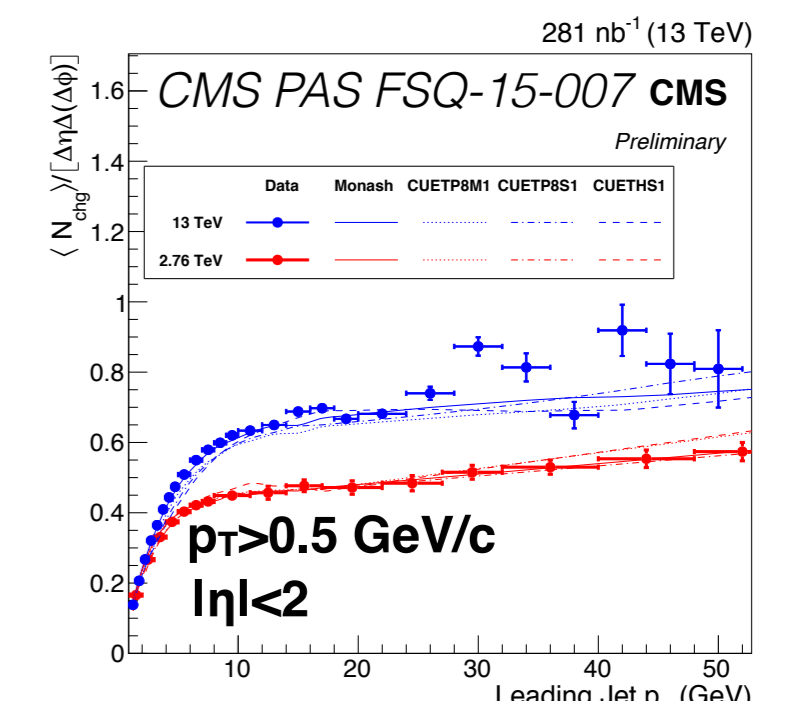


Analysis Method - cont'

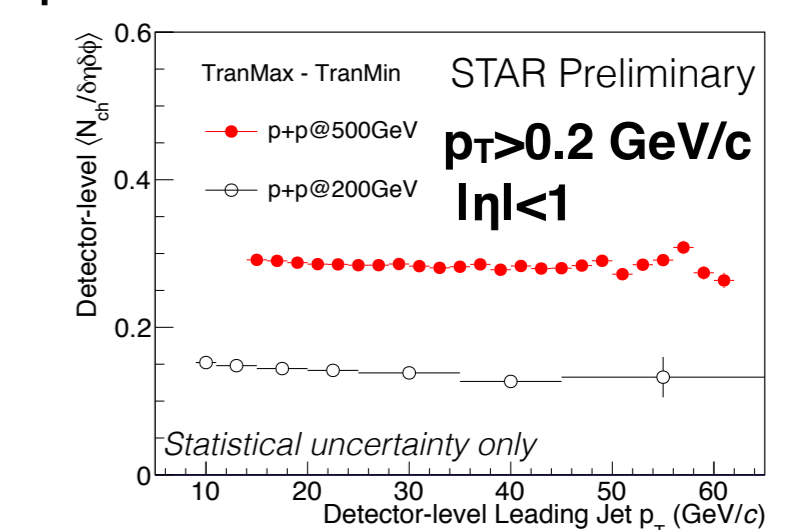
- Detector-level underlying event charged particle density comparison between collision energies



TransMax - TransMin
p+p@2.76 TeV, 13 TeV



p+p@200 GeV, 500 GeV



- At LHC energies, TransMax-TransMin increases with jet p_T
- At RHIC energies, TransMax-TransMin is flatter than LHC
- Hints of less Initial/Final State Radiation at RHIC energies

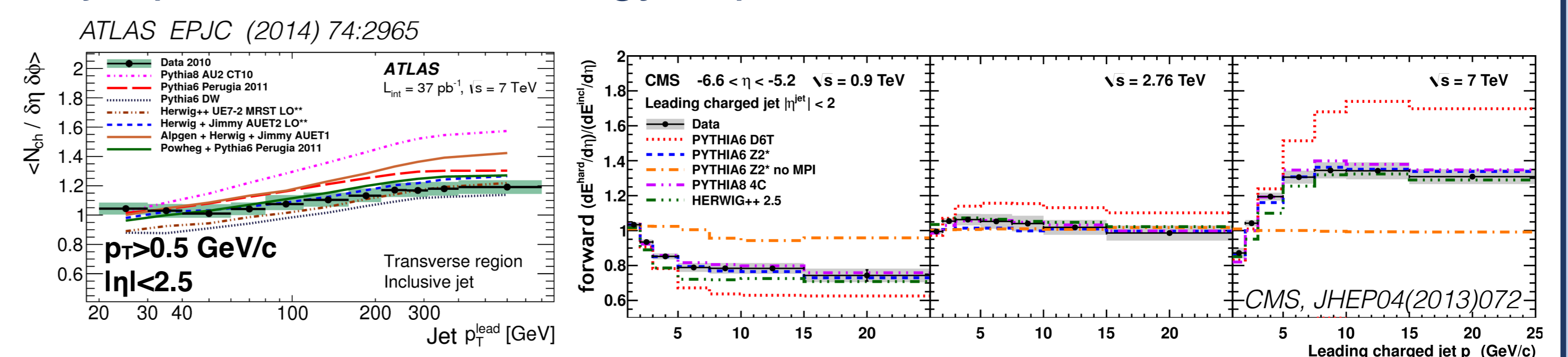
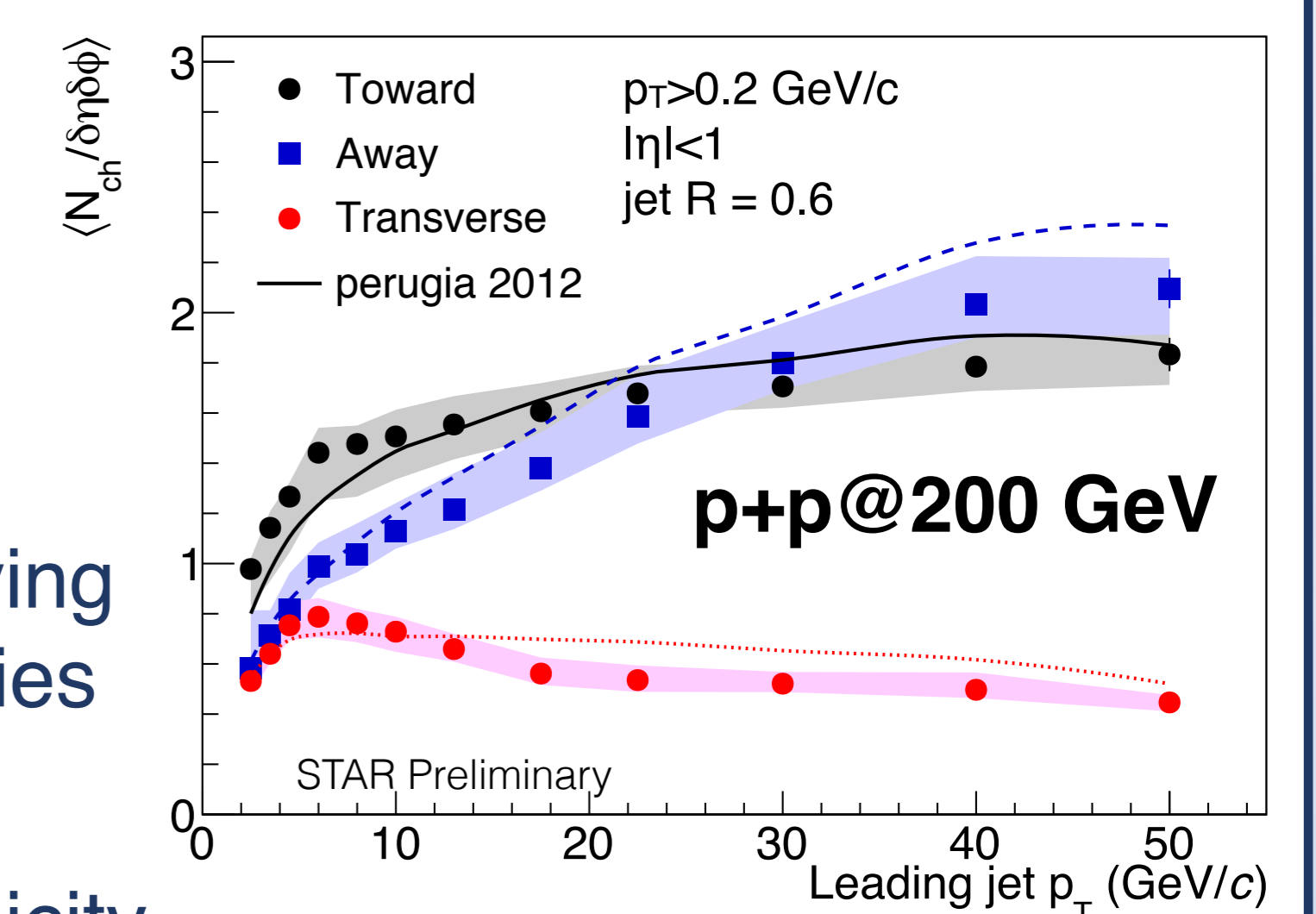
Unfolding Procedure:

- PYTHIA perugia 2012 through full GEANT simulation is embedded into Zero Bias real data
- RooUnfold* bayesian method is used for 2D unfolding

* <http://hepunix.rl.ac.uk/~adye/software/unfold/RooUnfold.html> T. Adye arXiv:1105.1160

Results & Discussions

- Towards and Away region charged particle densities are observed to increase quickly as leading jet p_T increases below $\sim 6 \text{ GeV}/c$, then gradually increase
- Transverse charged particle density increases as leading jet p_T below $\sim 6 \text{ GeV}/c$, then slightly decreases at higher leading jet p_T
- RHIC energy has less underlying event activity than LHC energies
- At LHC energies: mid-rapidity transverse multiplicity increases with mid-rapidity jet p_T ; forward energy density vs mid-rapidity jet p_T has collision energy dependence



Outlook:

- Underlying event mean p_T provides further insight into particle production mechanism
- Underlying activity on total multiplicity may shed light on origin of high-multiplicity p+p events