

INTRODUCING S_T TO STUDY UNDERLYING EVENTS IN PP COLLISIONS

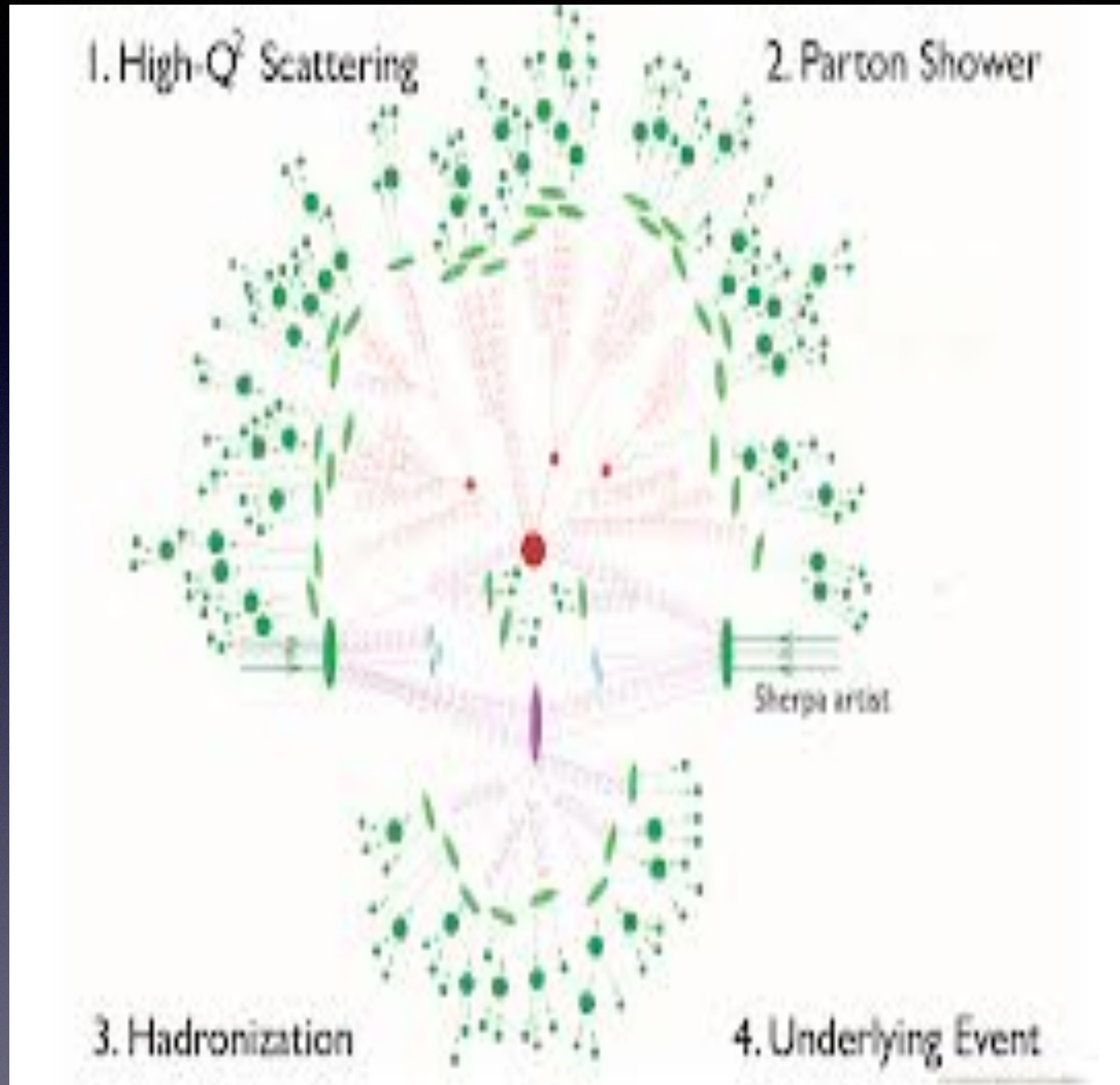
SADHANA DASH

IIT BOMBAY

(IN COLLABORATION WITH RAHUL VERMA AND BASANTA NANDI)

India-JINR Workshop, 16 -18 October, 2023

Underlying Events



A p-p collision at LHC can be interpreted as a hard scattering between partons accompanied by Underlying Event (UE).

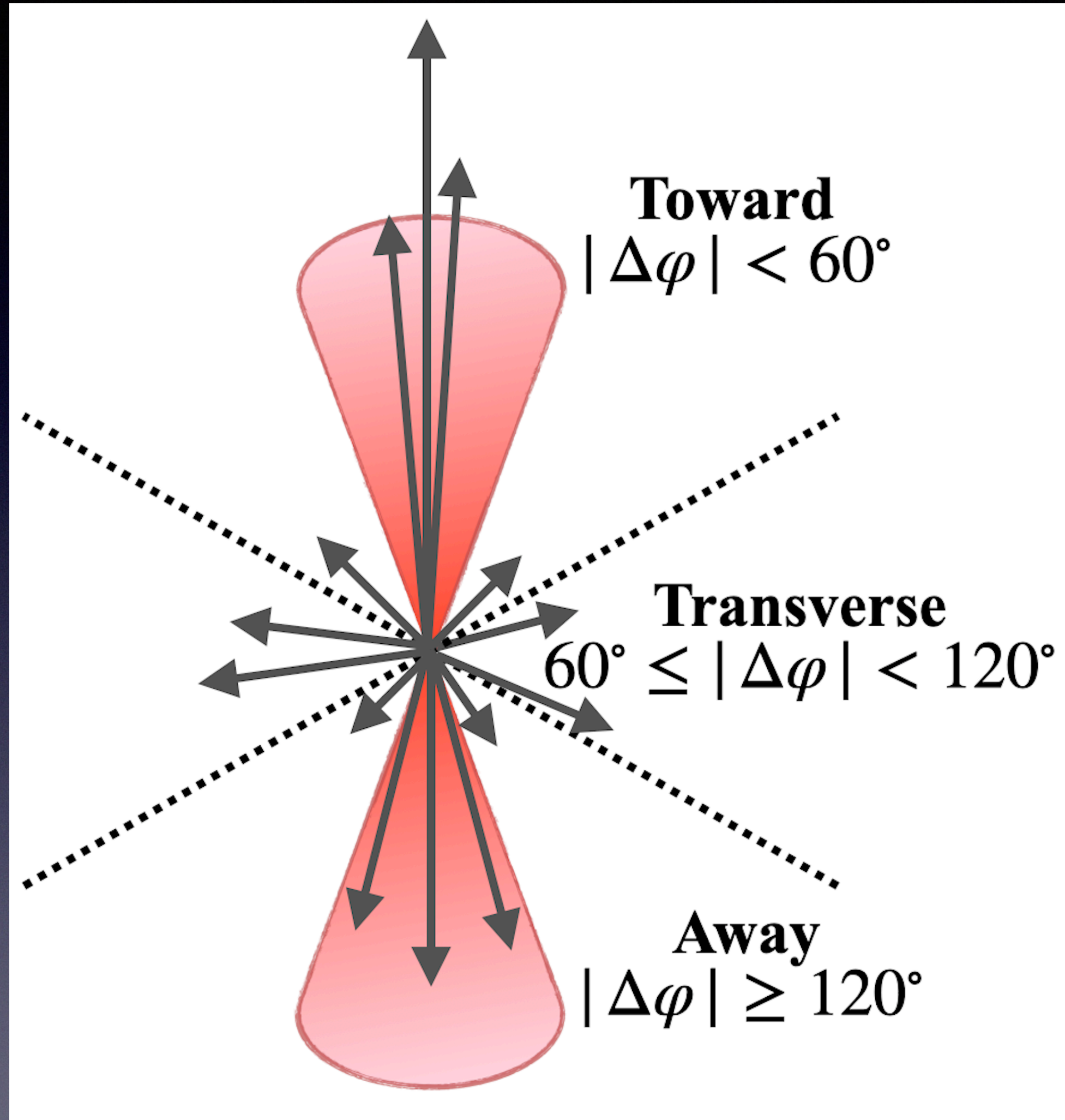
It consists of:

Initial and final state radiation (ISR & FSR)

Beam - Beam remnants (BBR)

Multiple (soft) Parton Interactions (MPI)

Quantifying UE ...



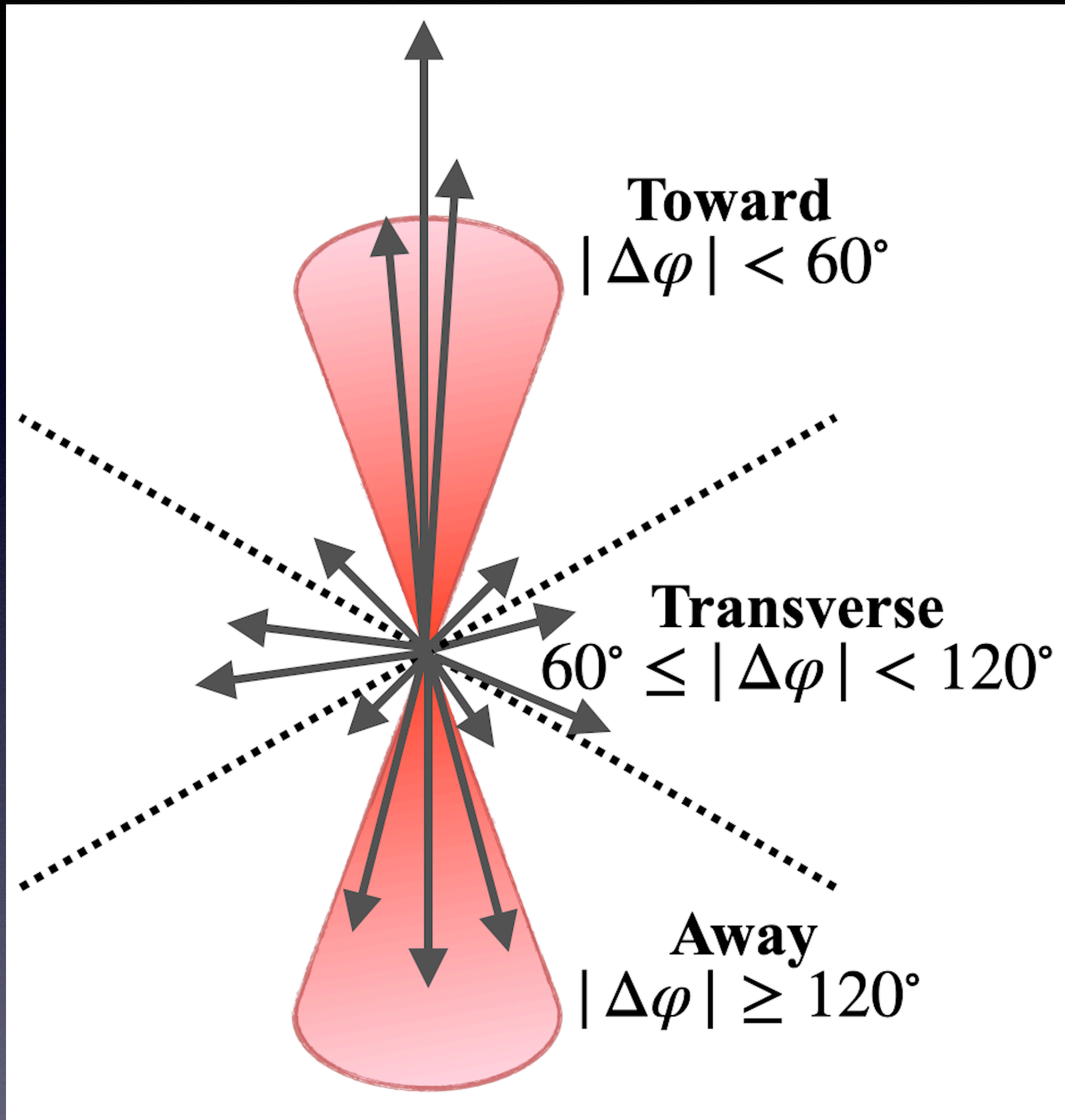
p_{Tlead} : Largest p_T particle/track in the event

$|\Delta\phi| = |\phi - \phi_{lead}|$: Azimuthal angular difference

Define three azimuthal regions

1. **Toward region** : $|\Delta\phi| < 60^\circ$
2. **Transverse region** : $60^\circ < |\Delta\phi| < 120^\circ$
3. **Away region** : $|\Delta\phi| > 120^\circ$

Quantifying UE ...



1. Toward region : $|\Delta\phi| < 60^\circ$
2. Transverse region : $60^\circ < |\Delta\phi| < 120^\circ$
3. Away region : $|\Delta\phi| > 120^\circ$

Transverse Region is most sensitive to the UE activity

UE Activity Observables

p_{Tlead} : Largest p_T particle/track in the event

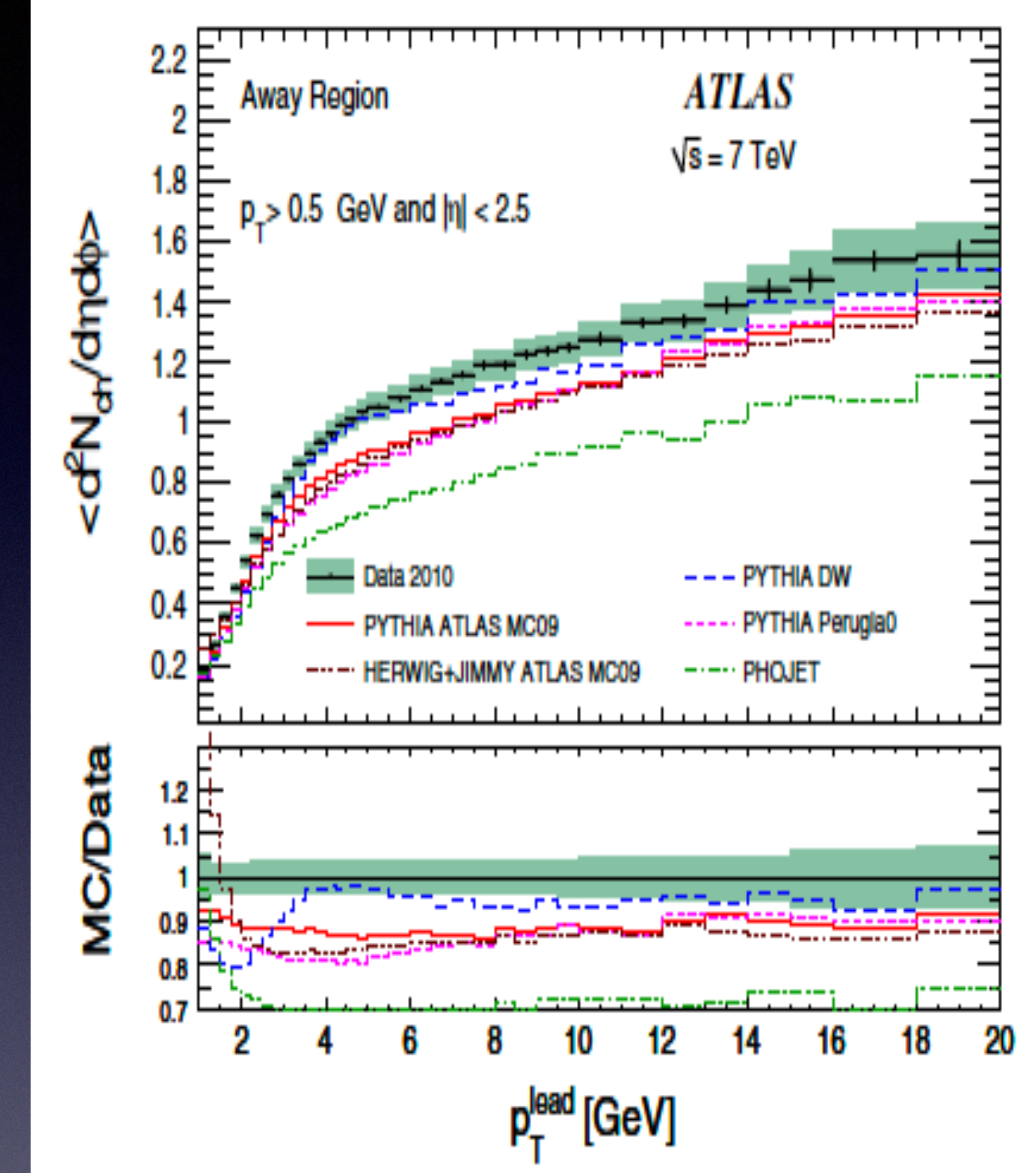
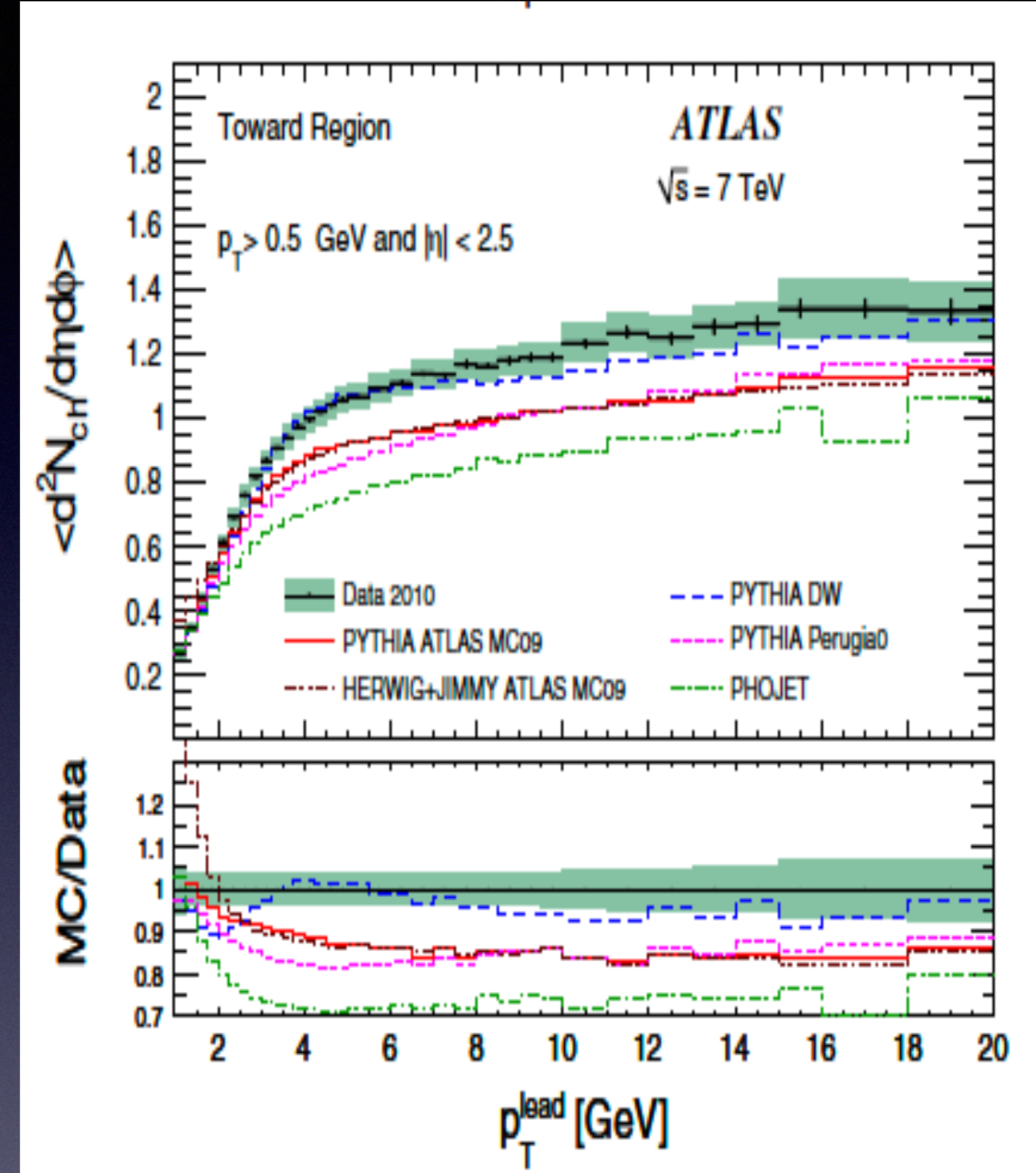
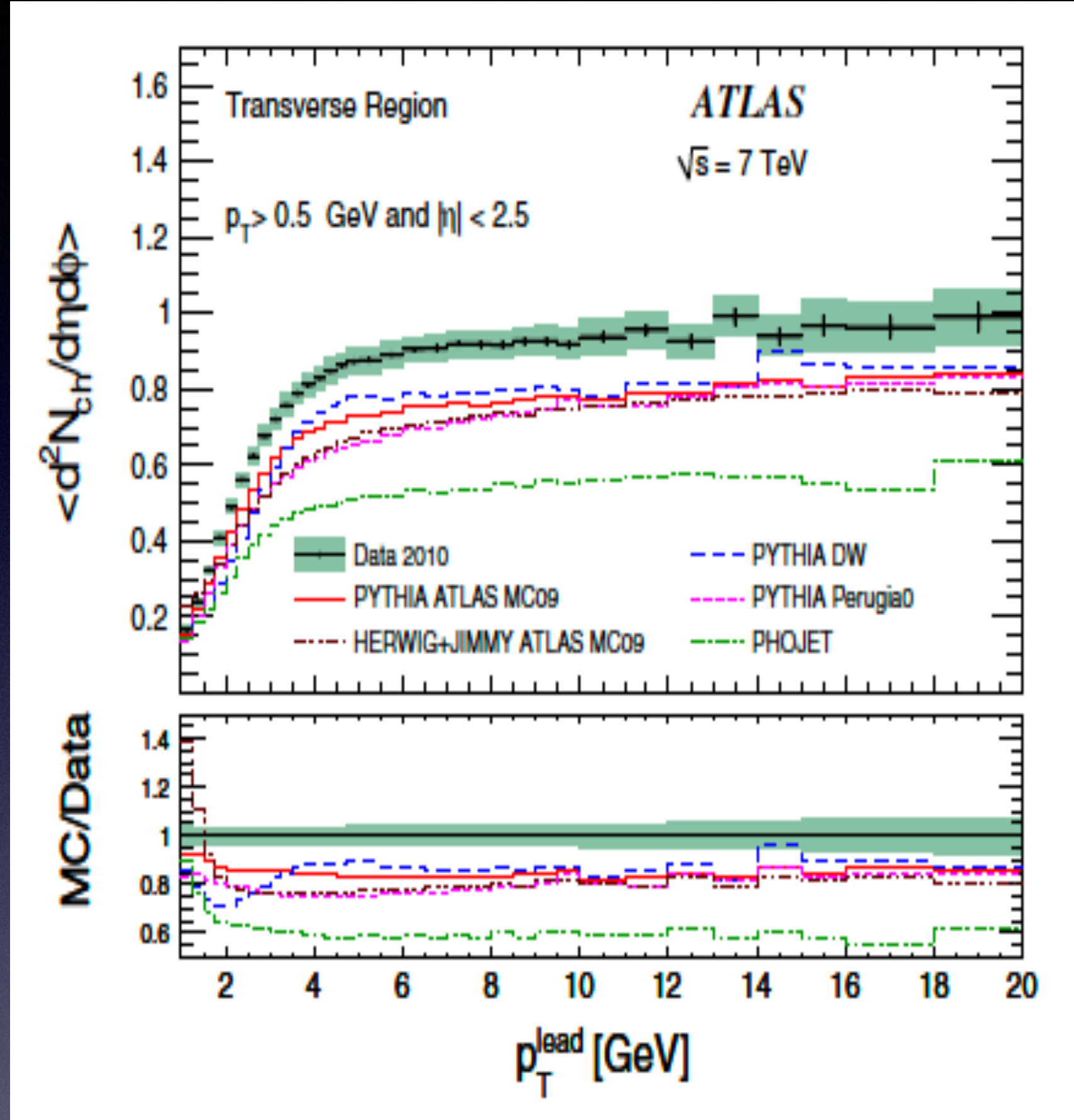
$\langle d^2 N_{ch} / d\eta d\phi \rangle$: Mean number of charged particles per unit $\eta - \phi$

$\langle d^2 \sum p_T / d\eta d\phi \rangle$: Mean scalar p_T sum number of charged particles per unit $\eta - \phi$

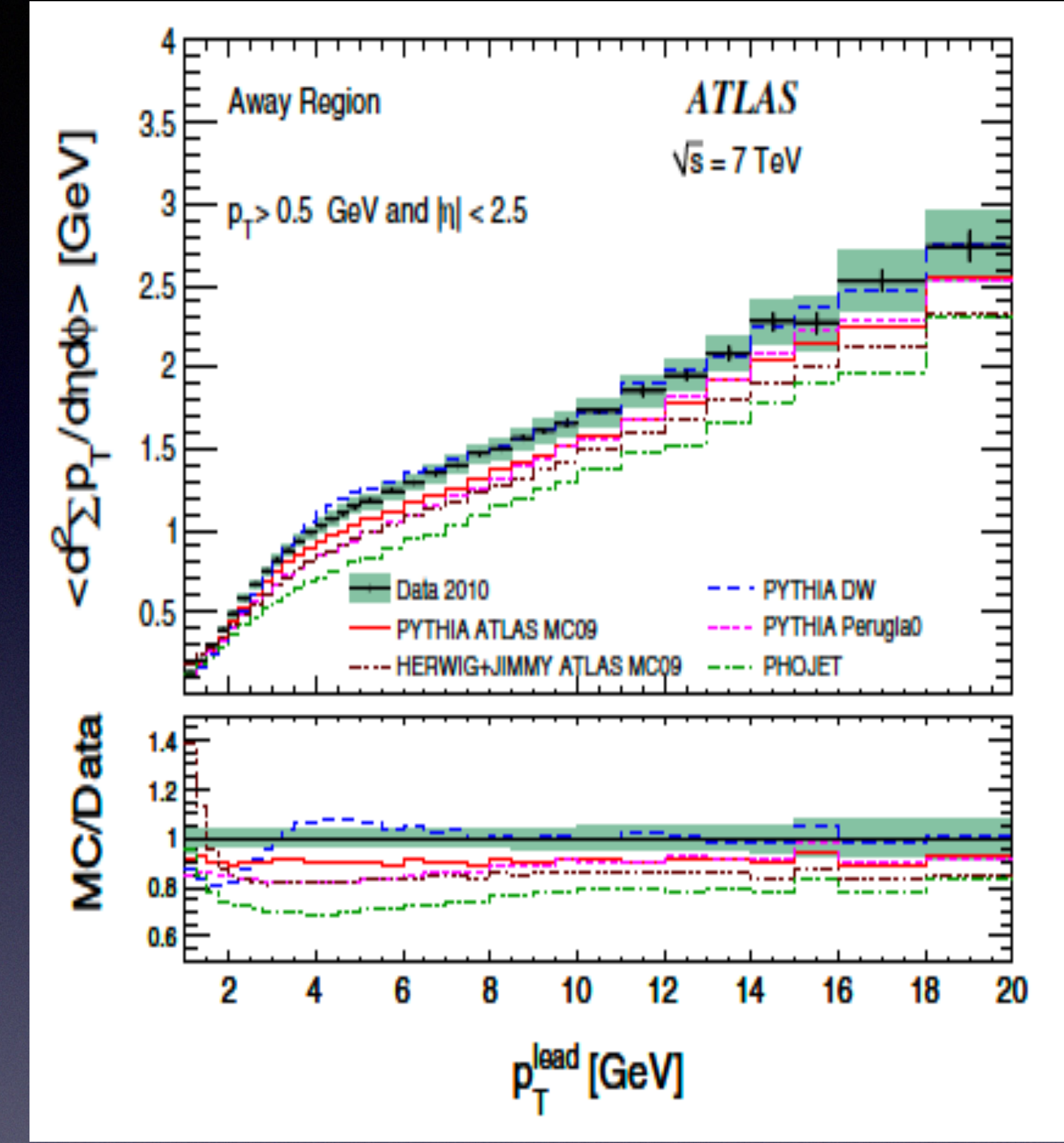
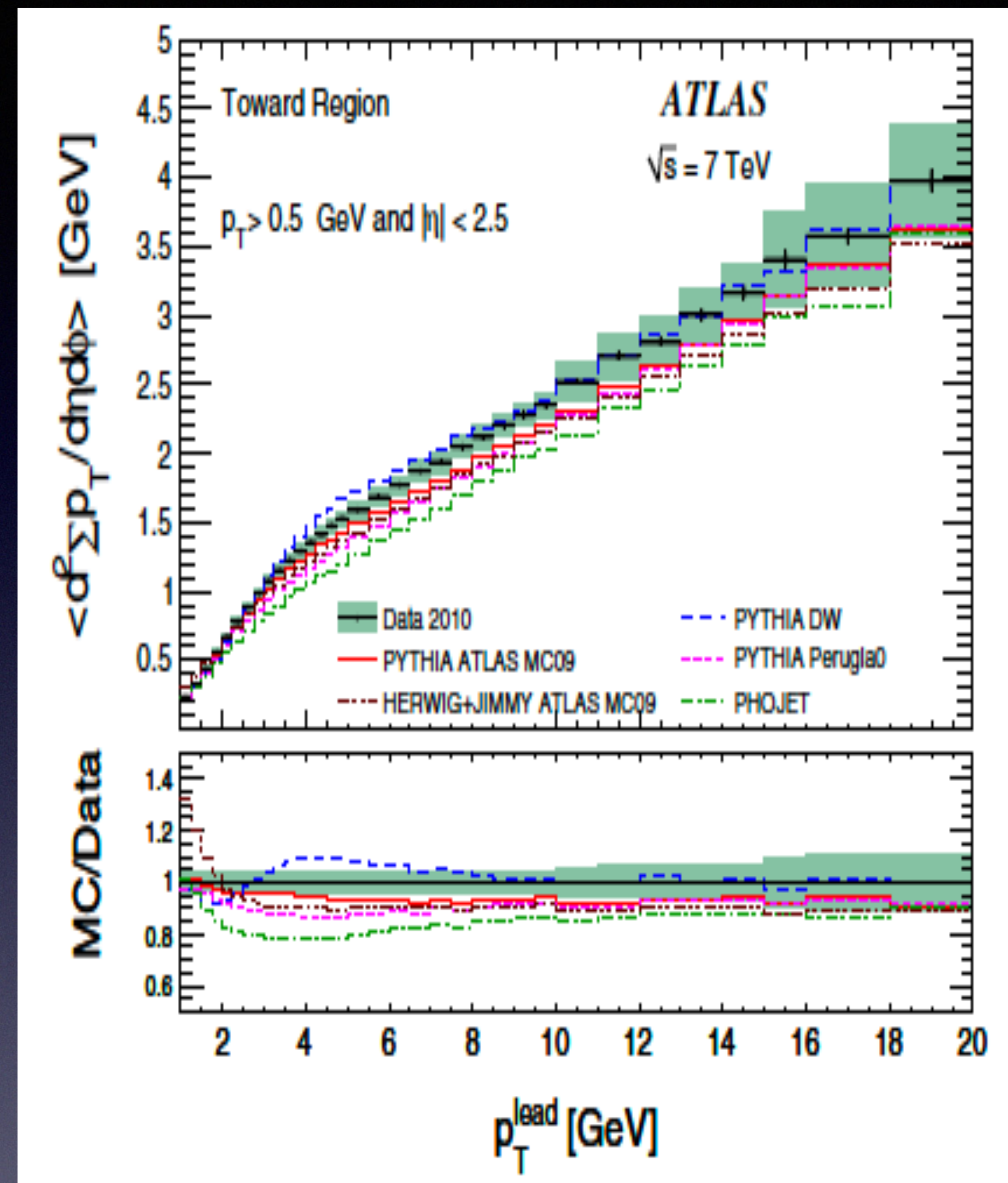
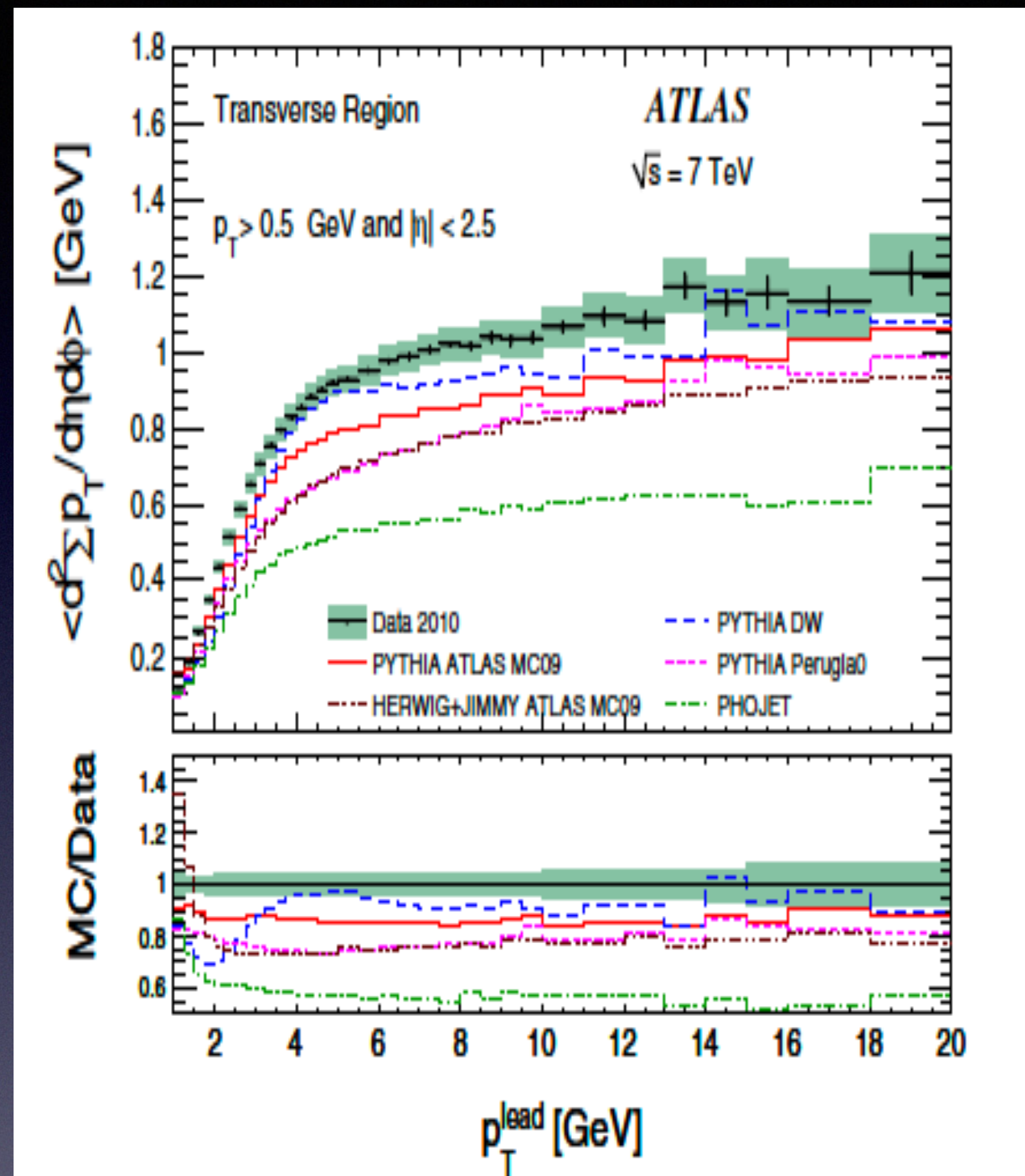
Angular distribution of number density

Angular distribution of p_T density

UE Activity Observables



UE Activity Observables

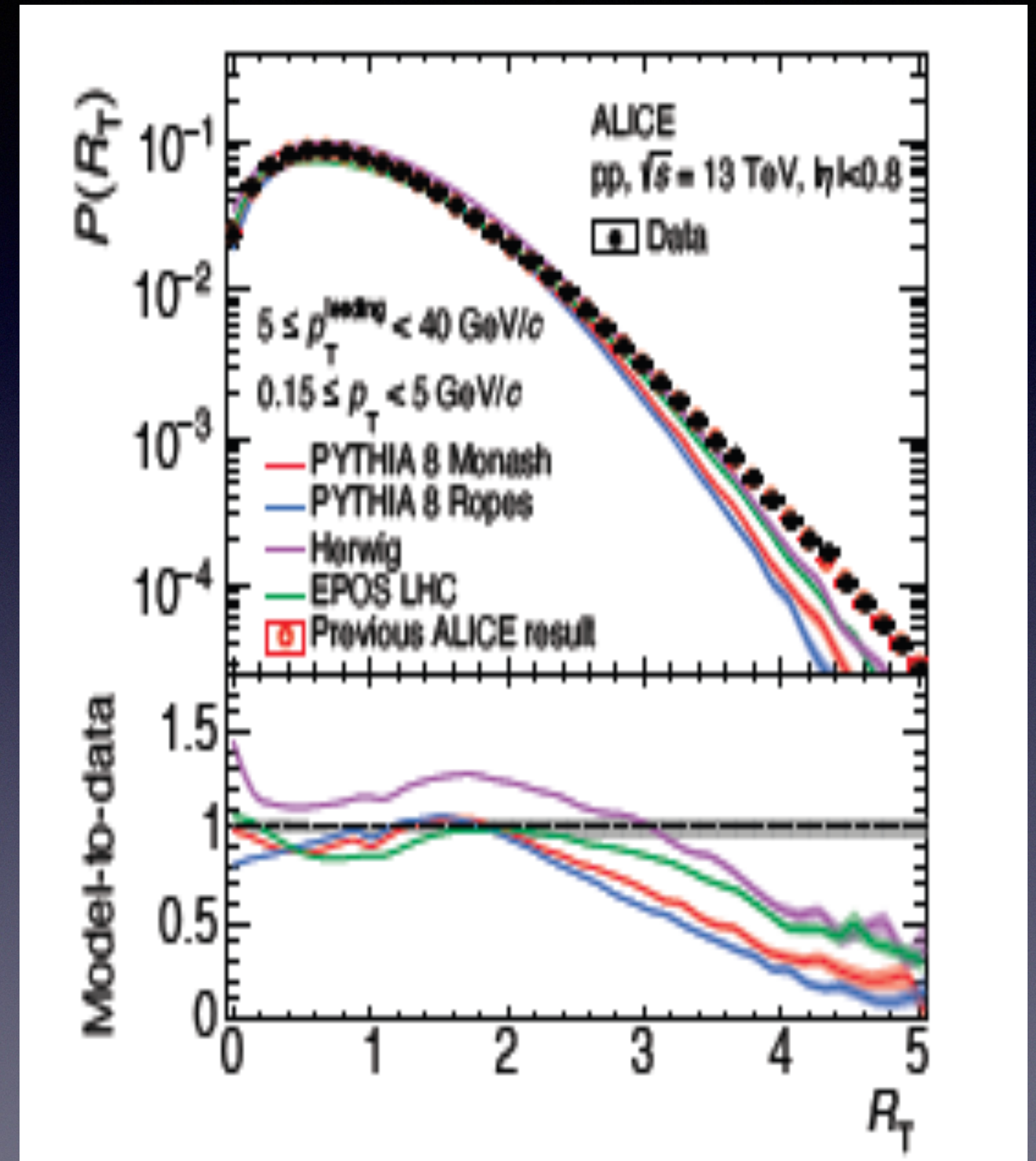


Transverse Activity classifier (I)

$$R_T = \frac{N_{trans}}{\langle N_{trans} \rangle}$$

N_{trans} : number of charged particles in the transverse region

$\langle N_{trans} \rangle$: mean number of charged particles in the transverse region over all considered events



Transverse Activity classifier (II)

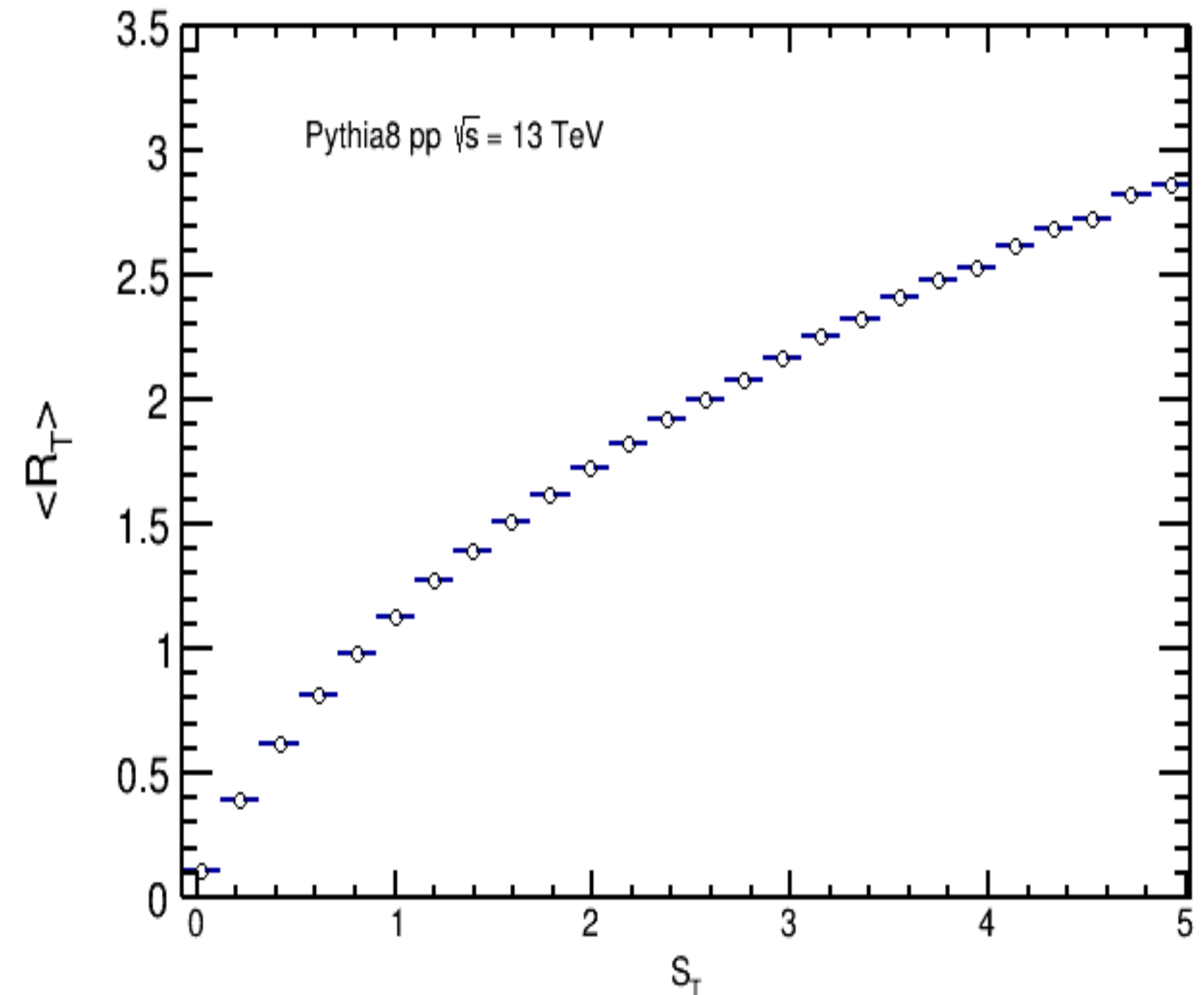
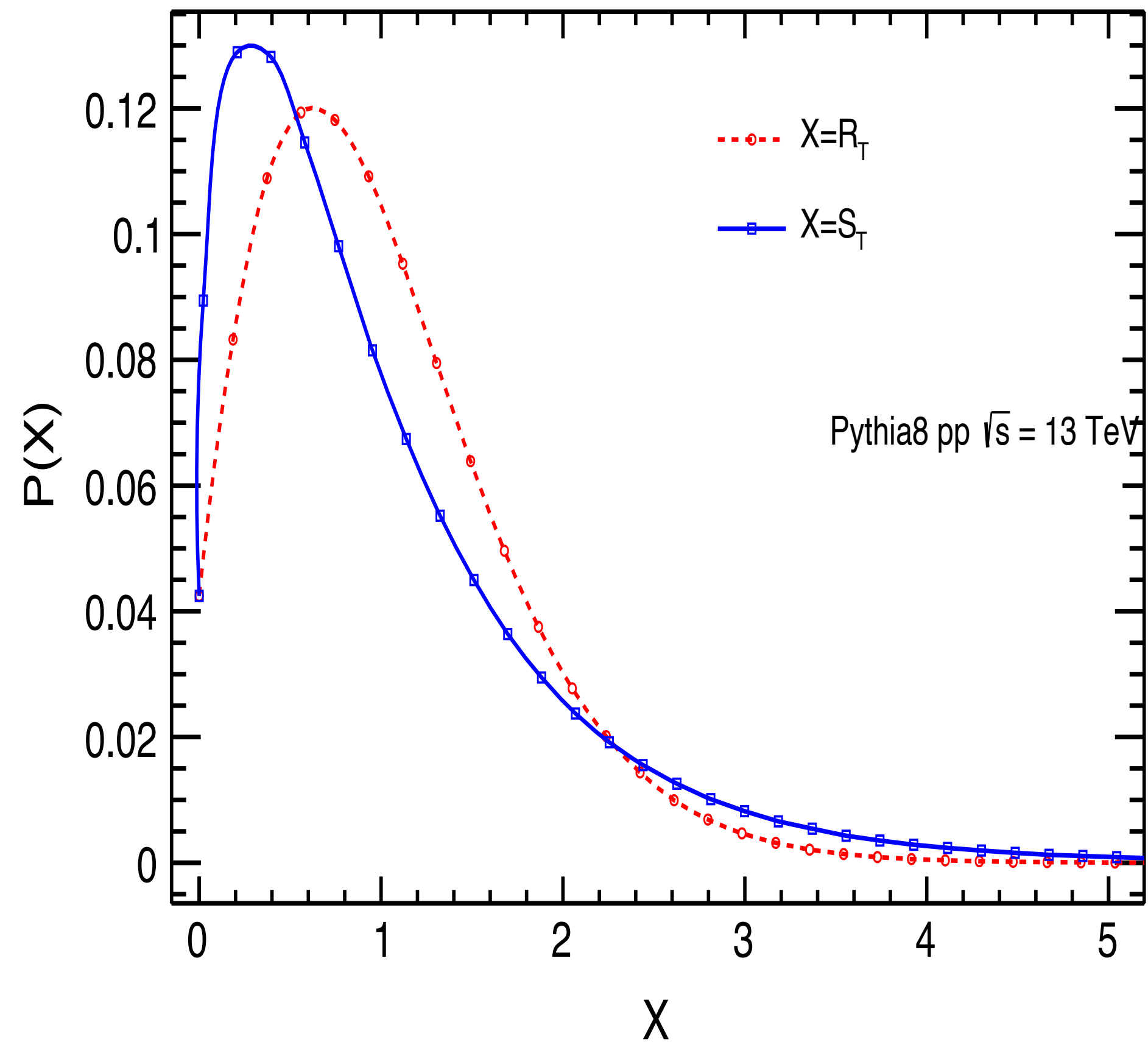
Introducing :

$$S_T = \frac{\sum p_{T_{trans}}}{\langle \sum p_{T_{trans}} \rangle}$$

$\sum p_{T_{trans}}$: sum of mean p_T of all charged particles in the transverse region

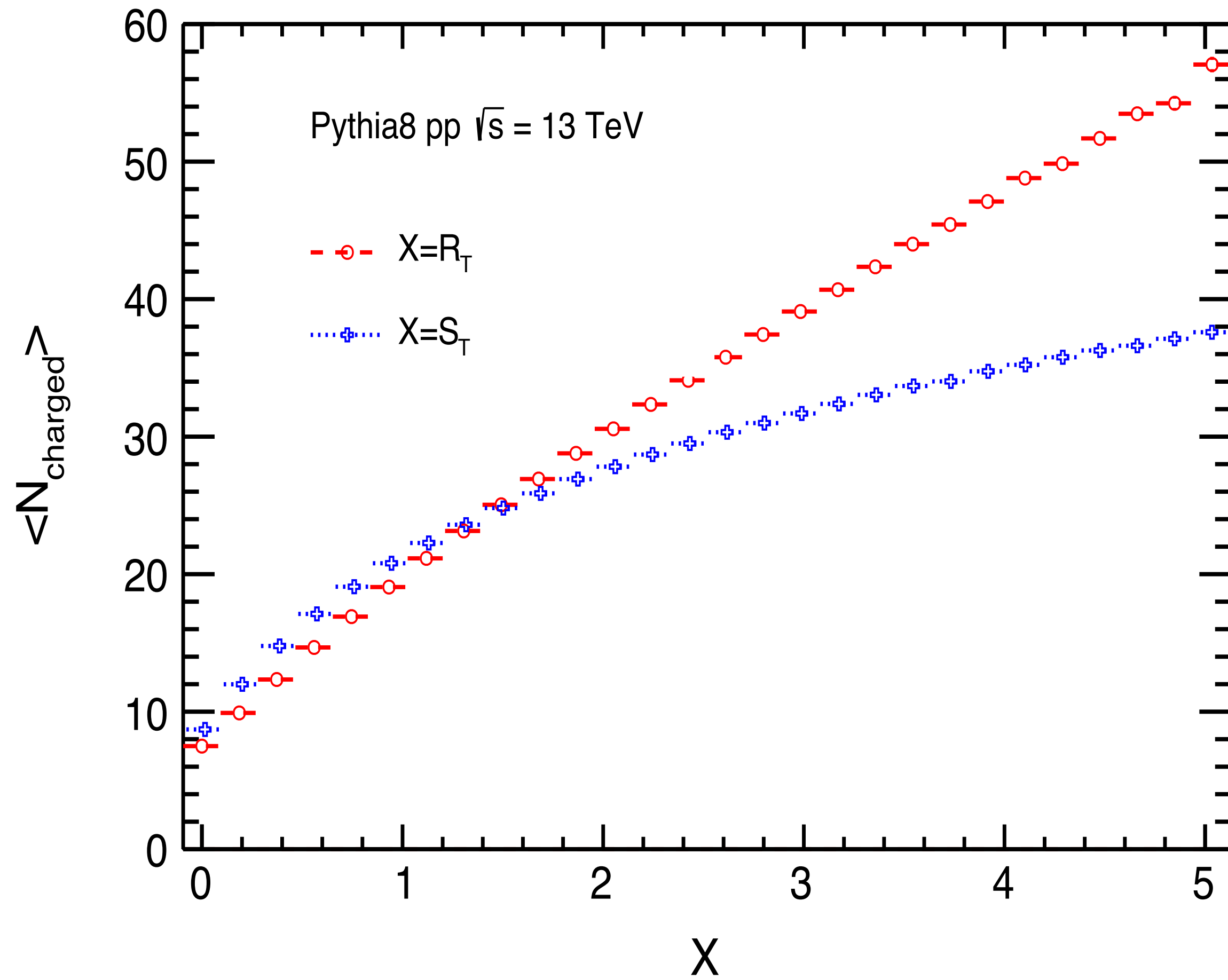
$\langle \sum p_{T_{trans}} \rangle$: mean of the $\sum p_{T_{trans}}$ over all considered events

R_T and S_T Distributions Pythia 8.3

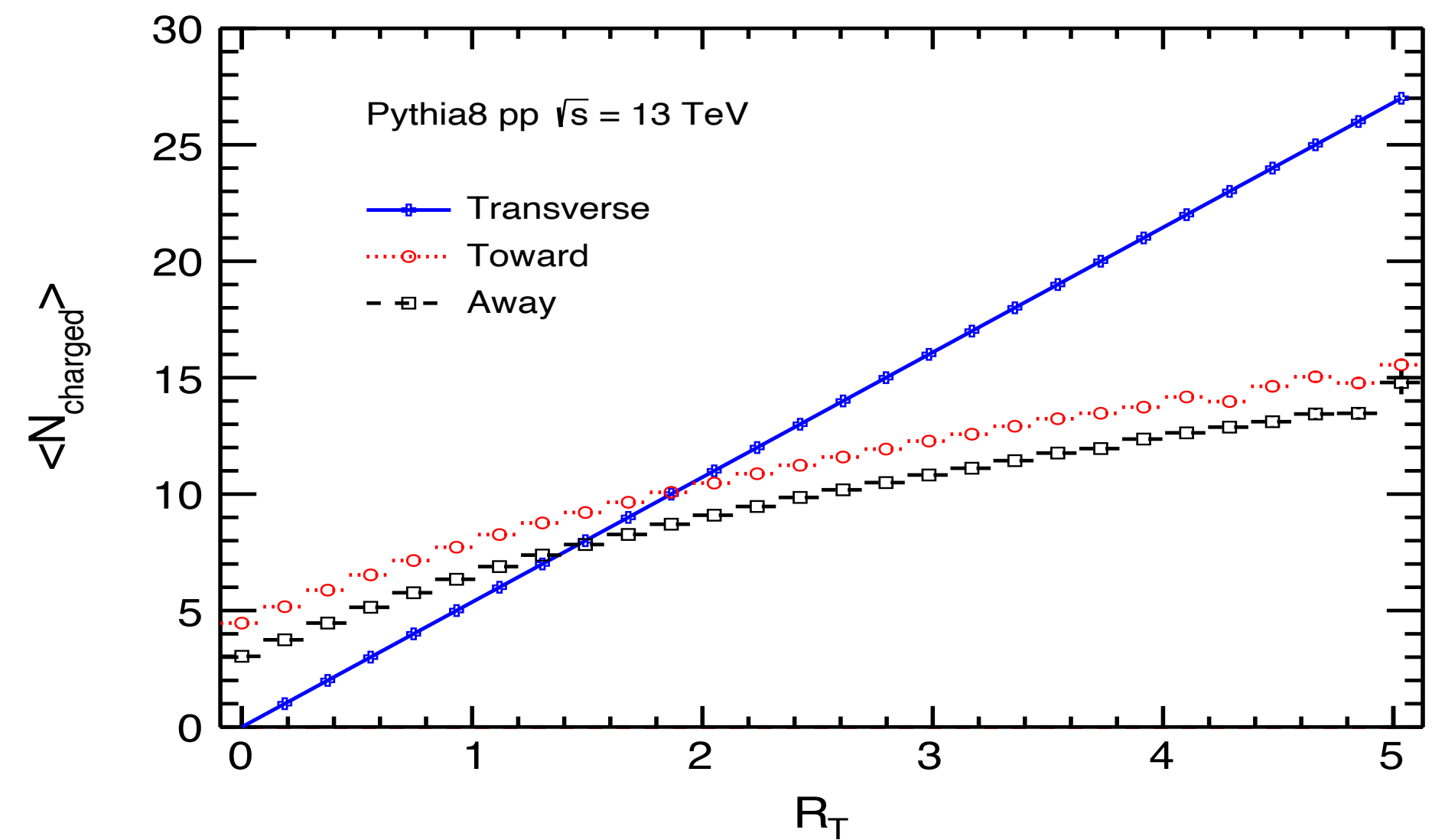
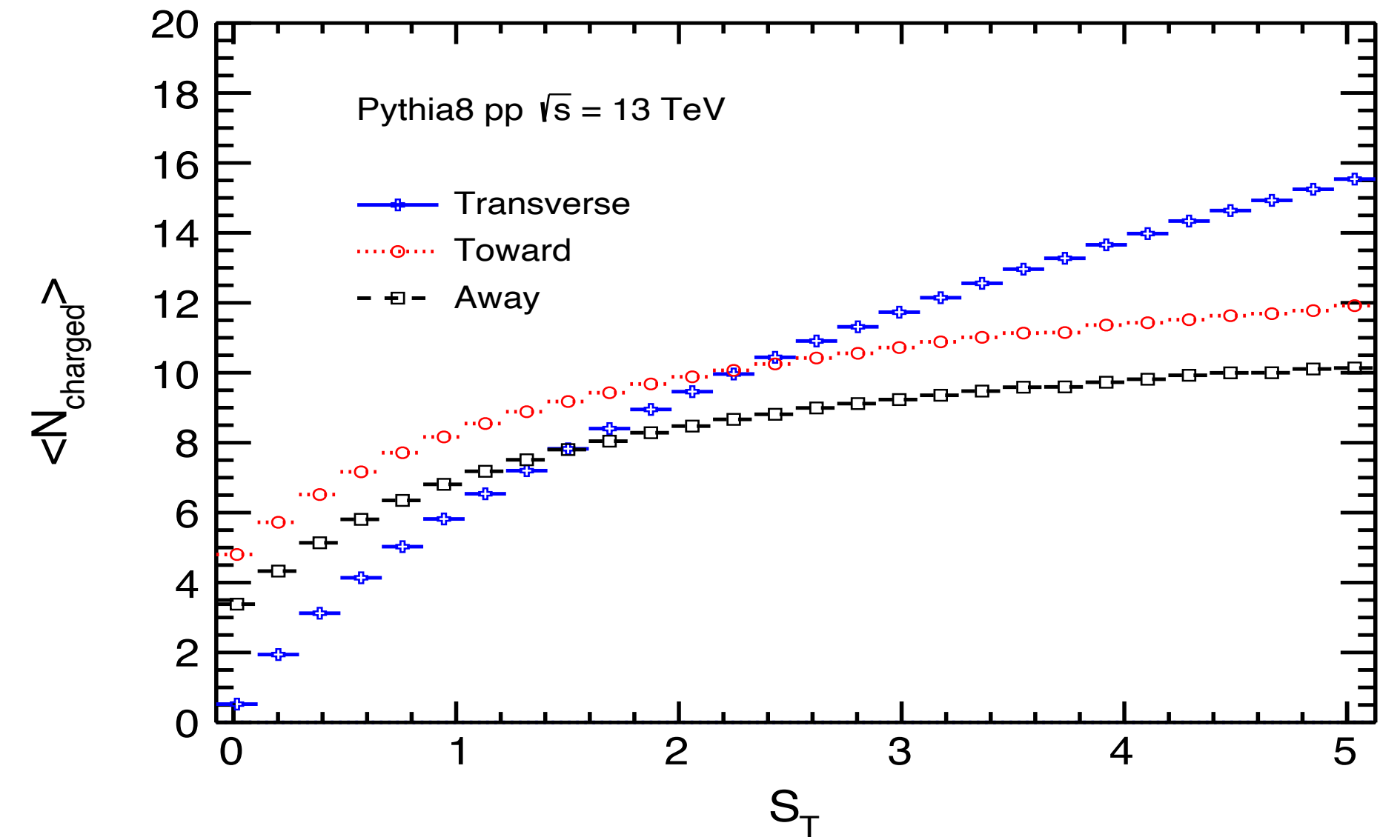


Similar trend for both the distributions and a close correlation

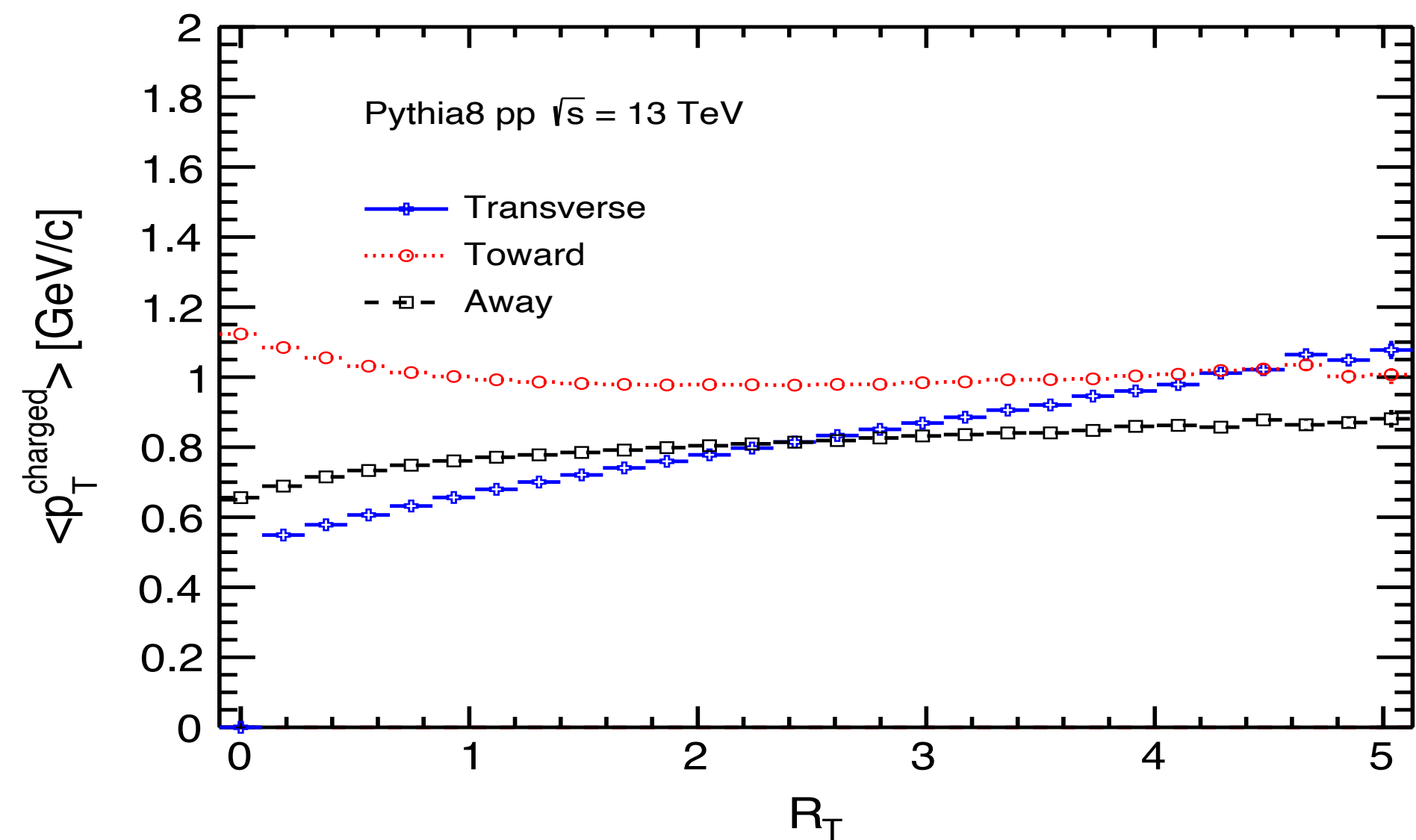
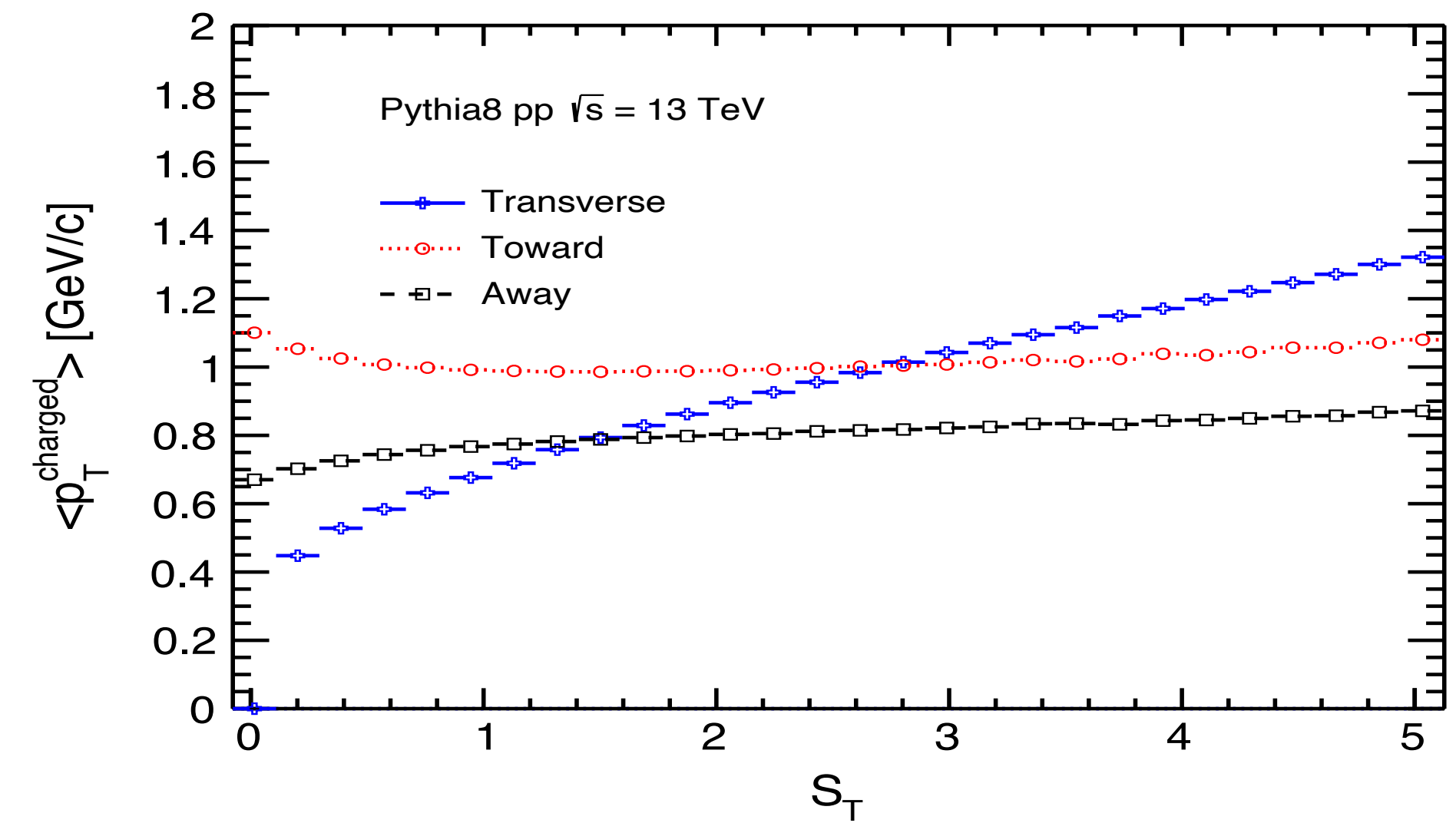
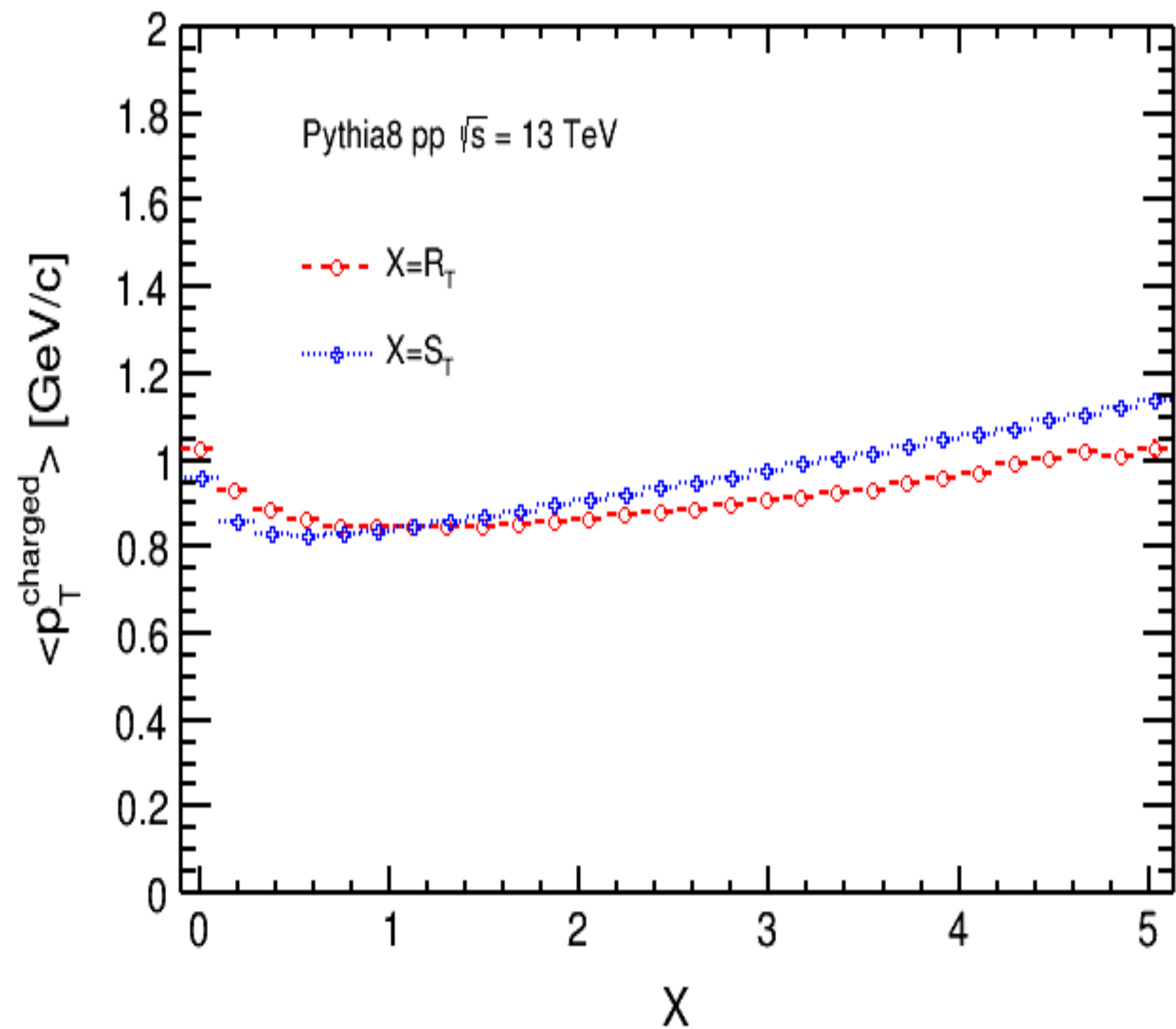
Distribution of $\langle N_{ch} \rangle$



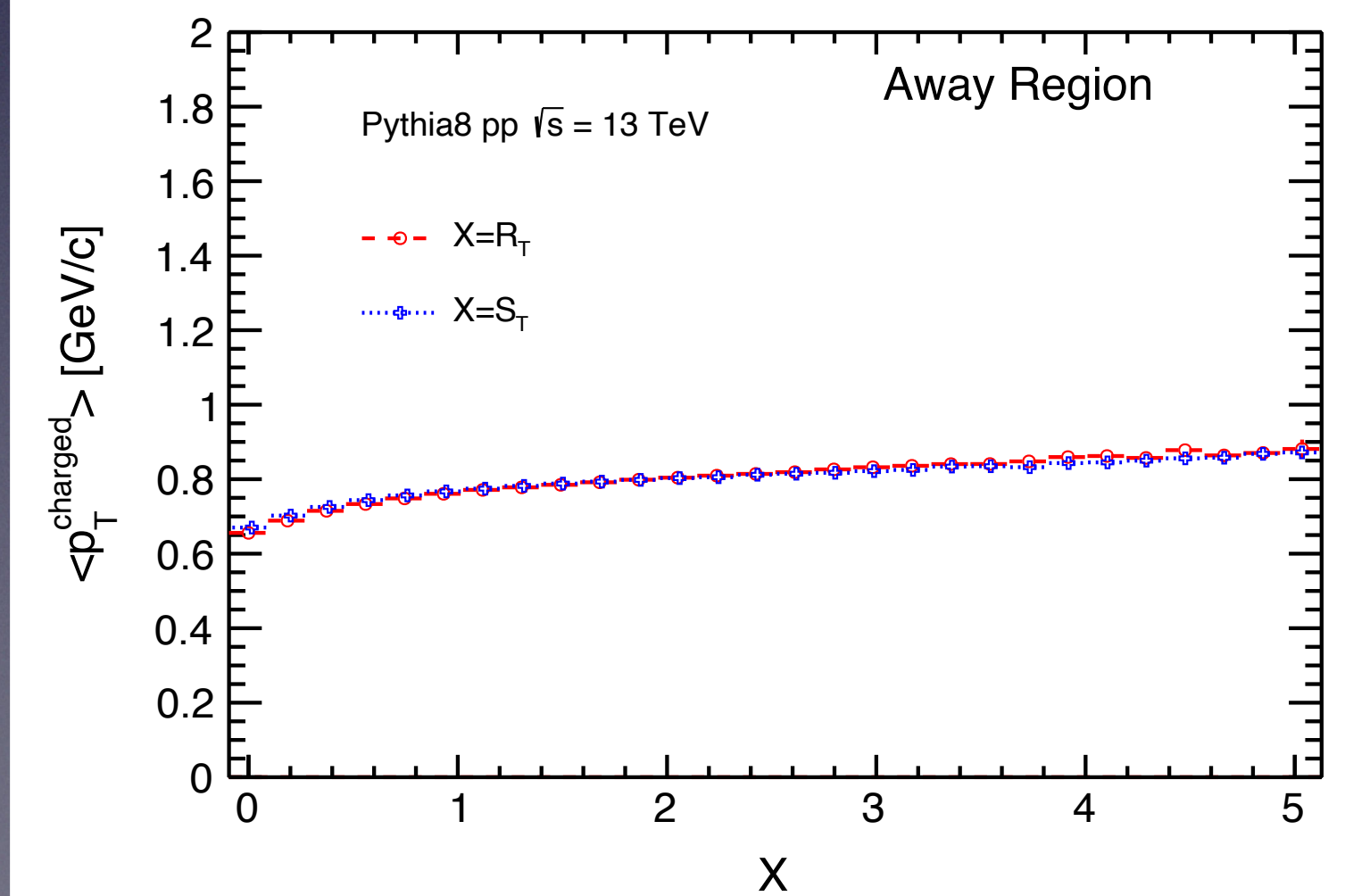
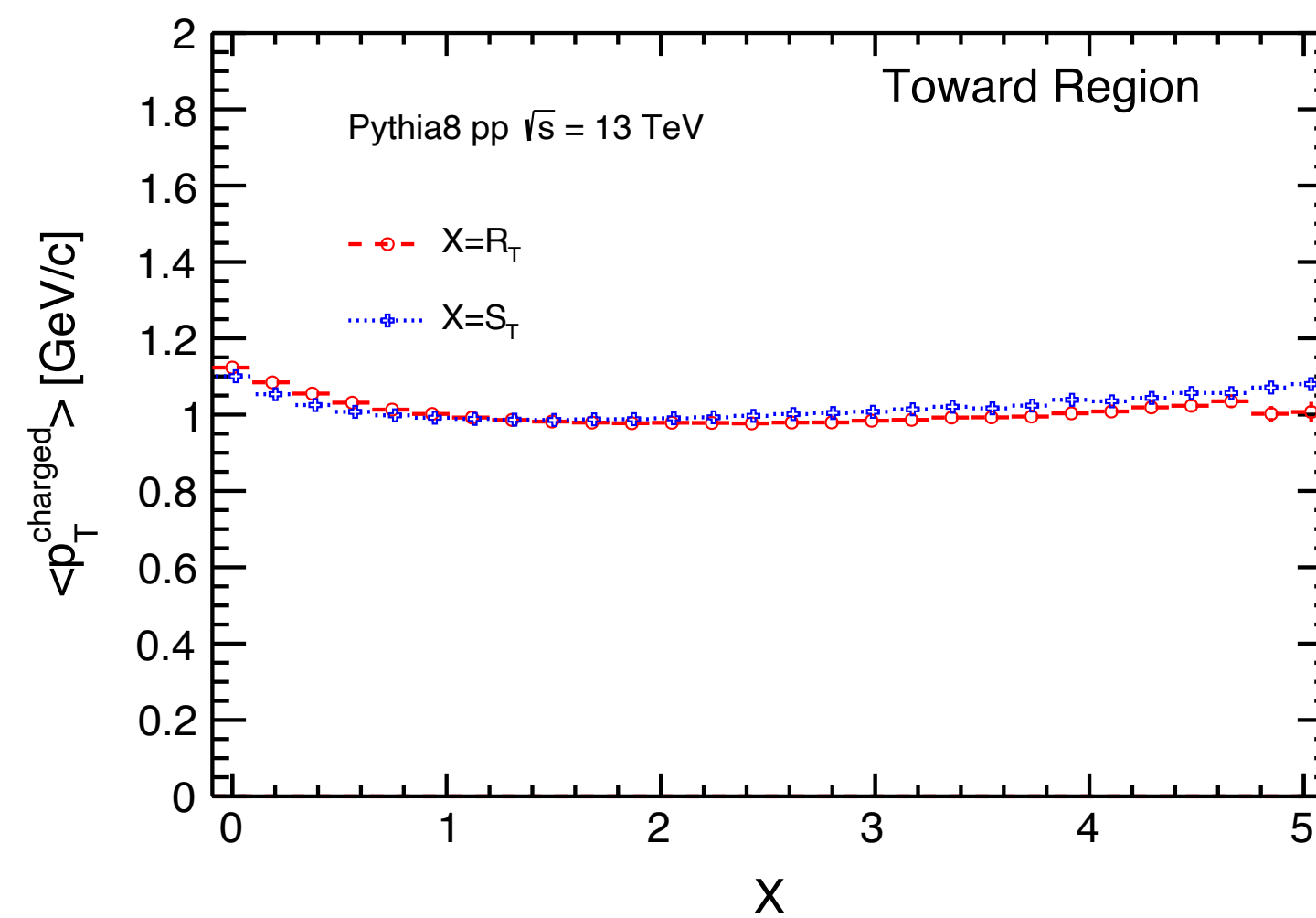
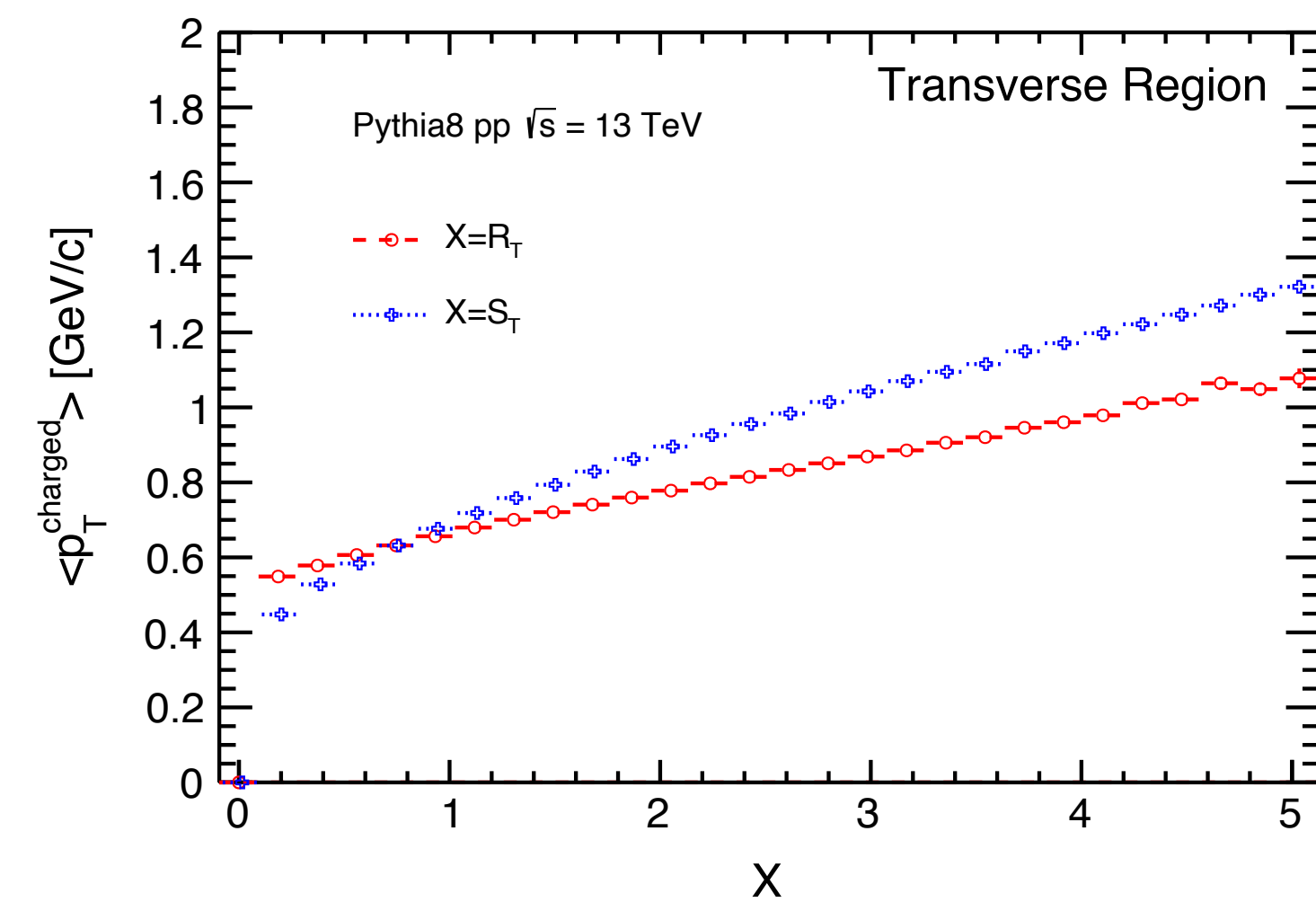
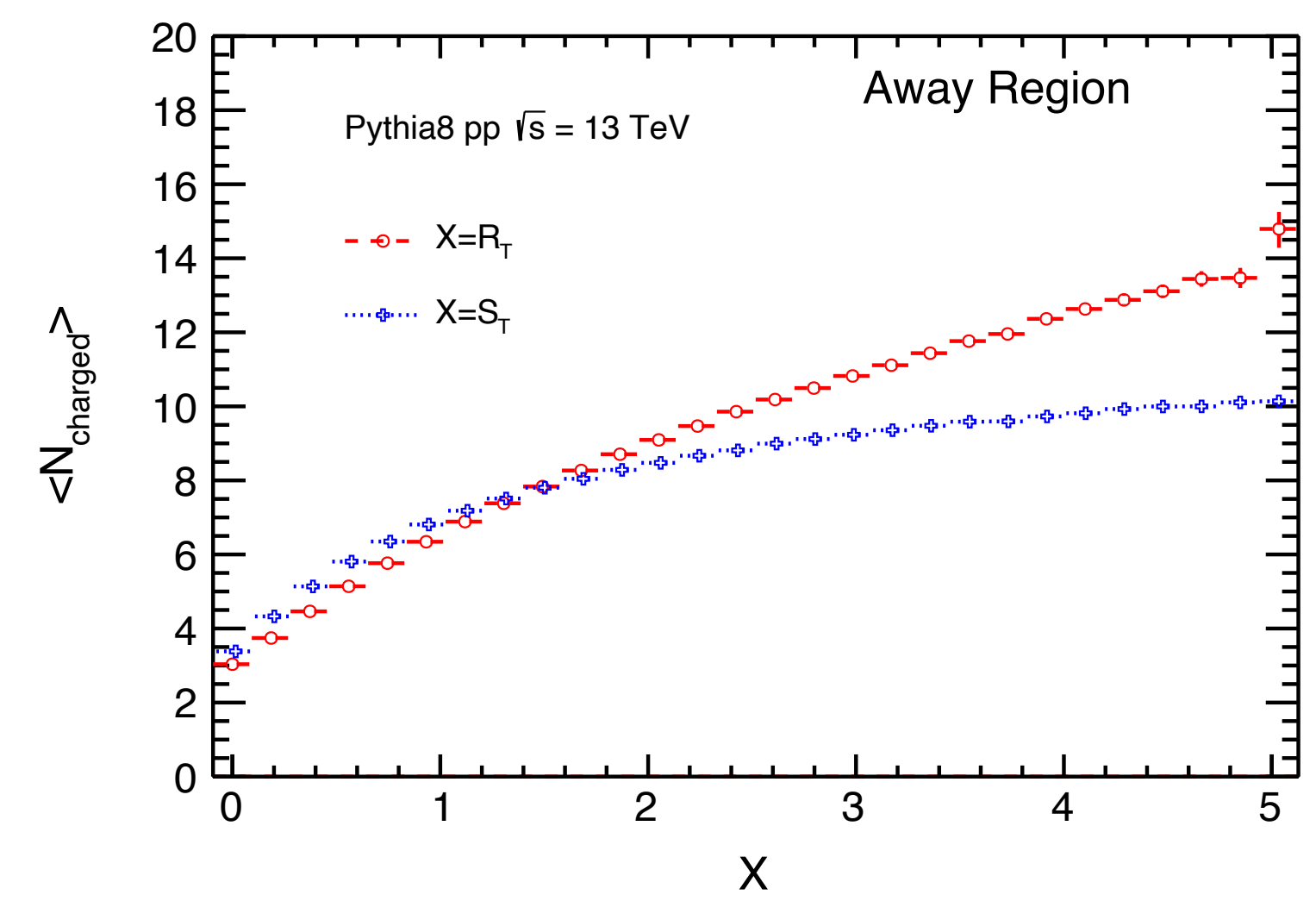
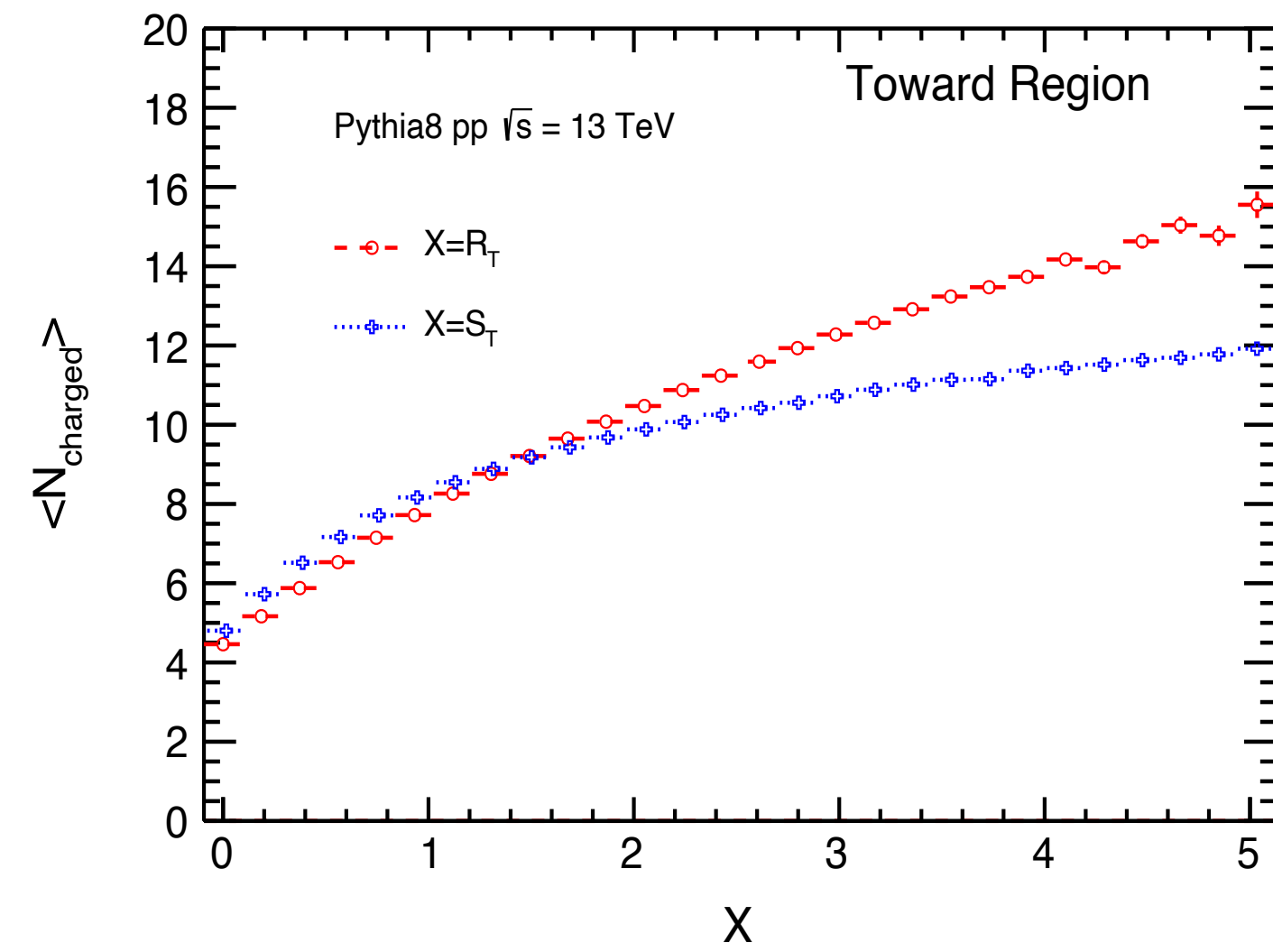
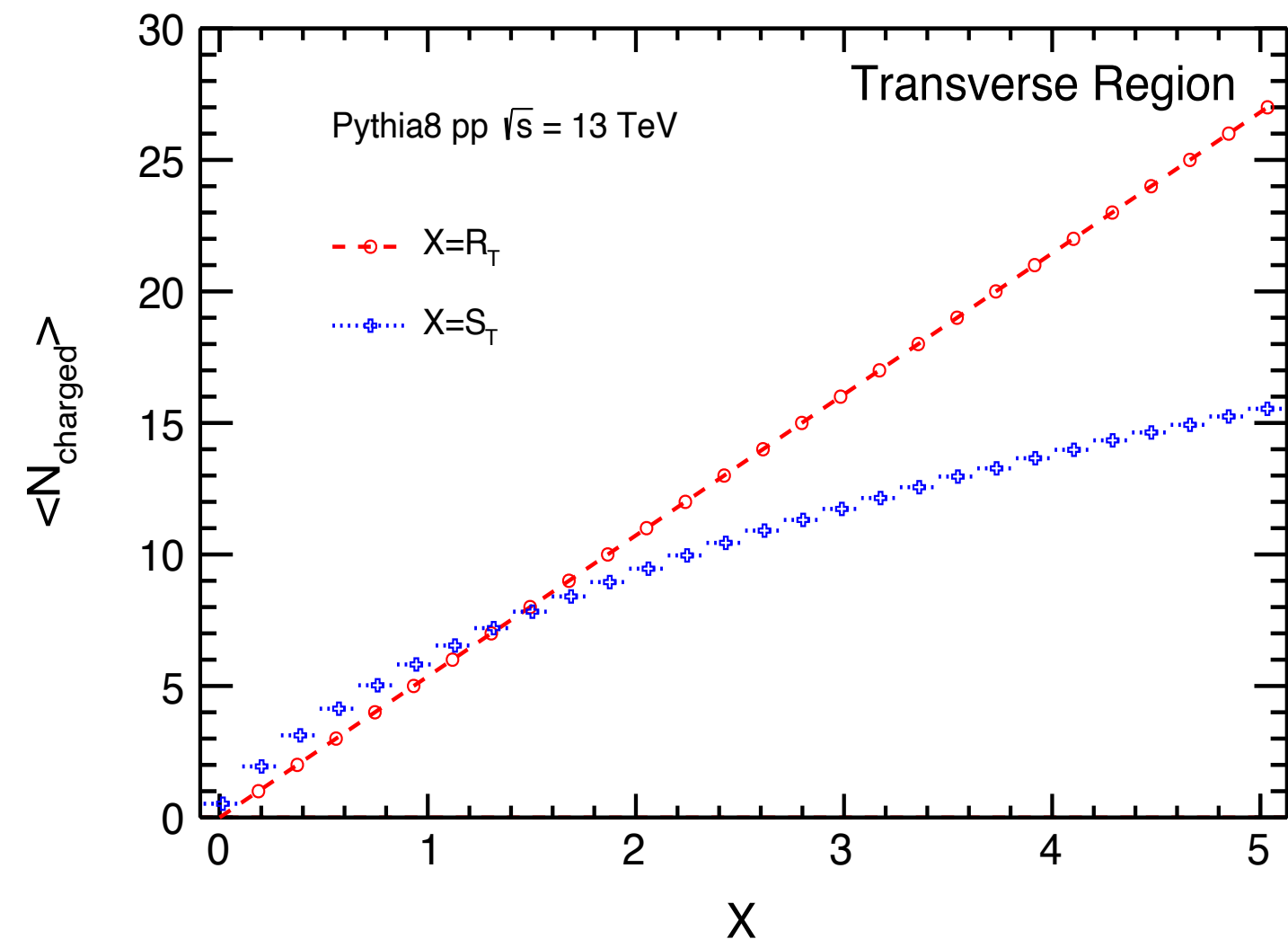
$\langle N_{ch} \rangle$ increases with an increase in transverse activity



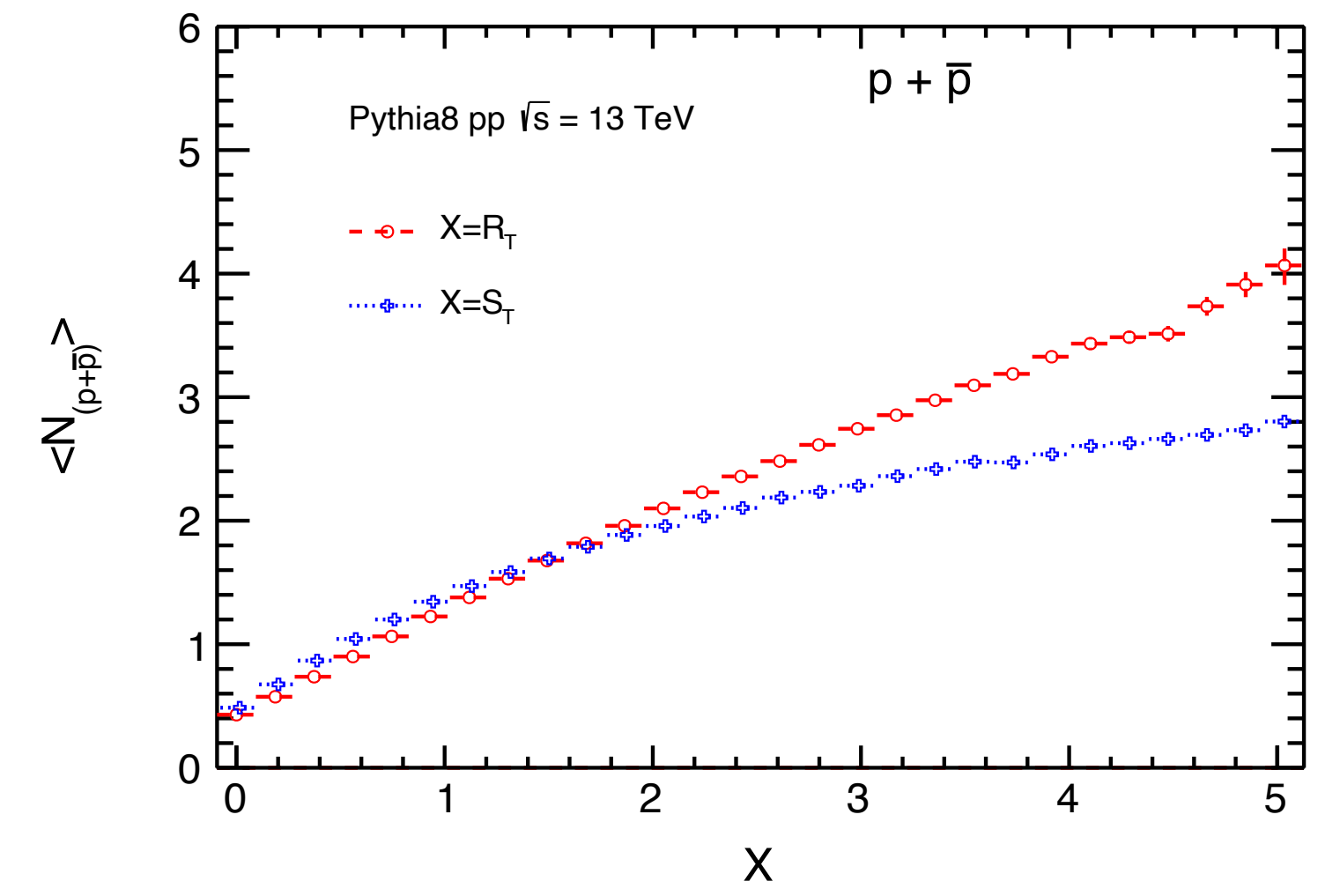
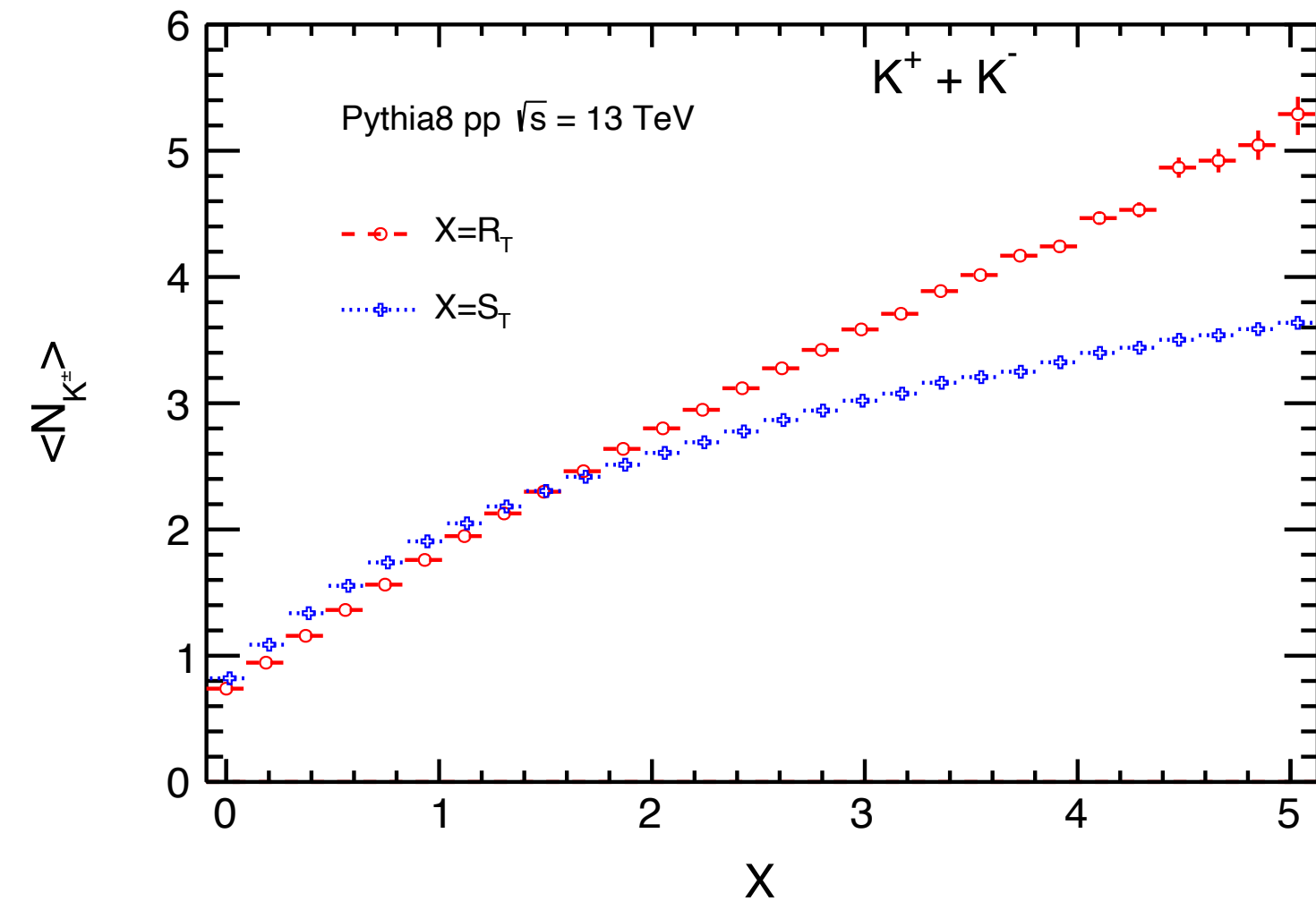
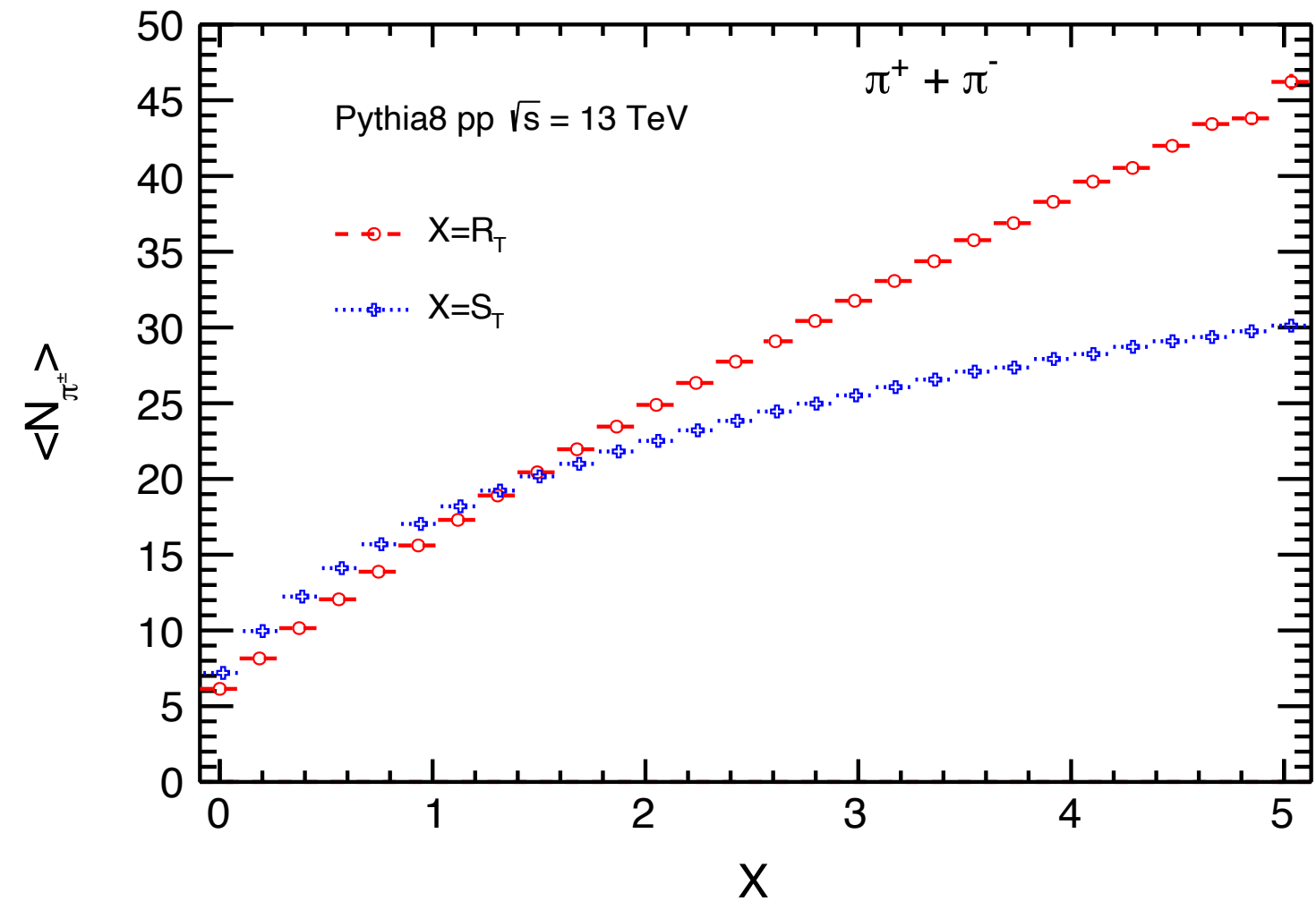
$\langle p_T \rangle$ distribution of charged particles



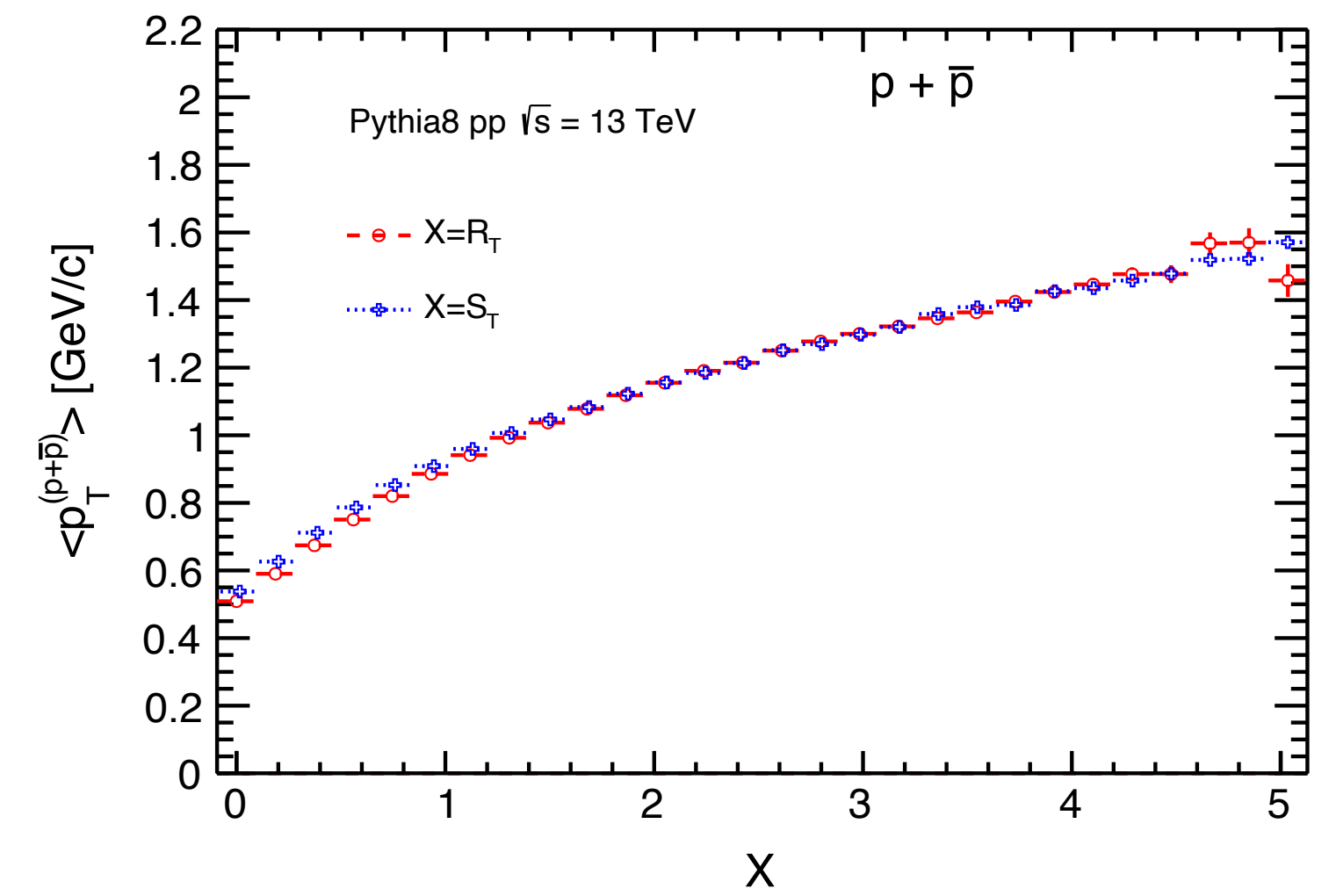
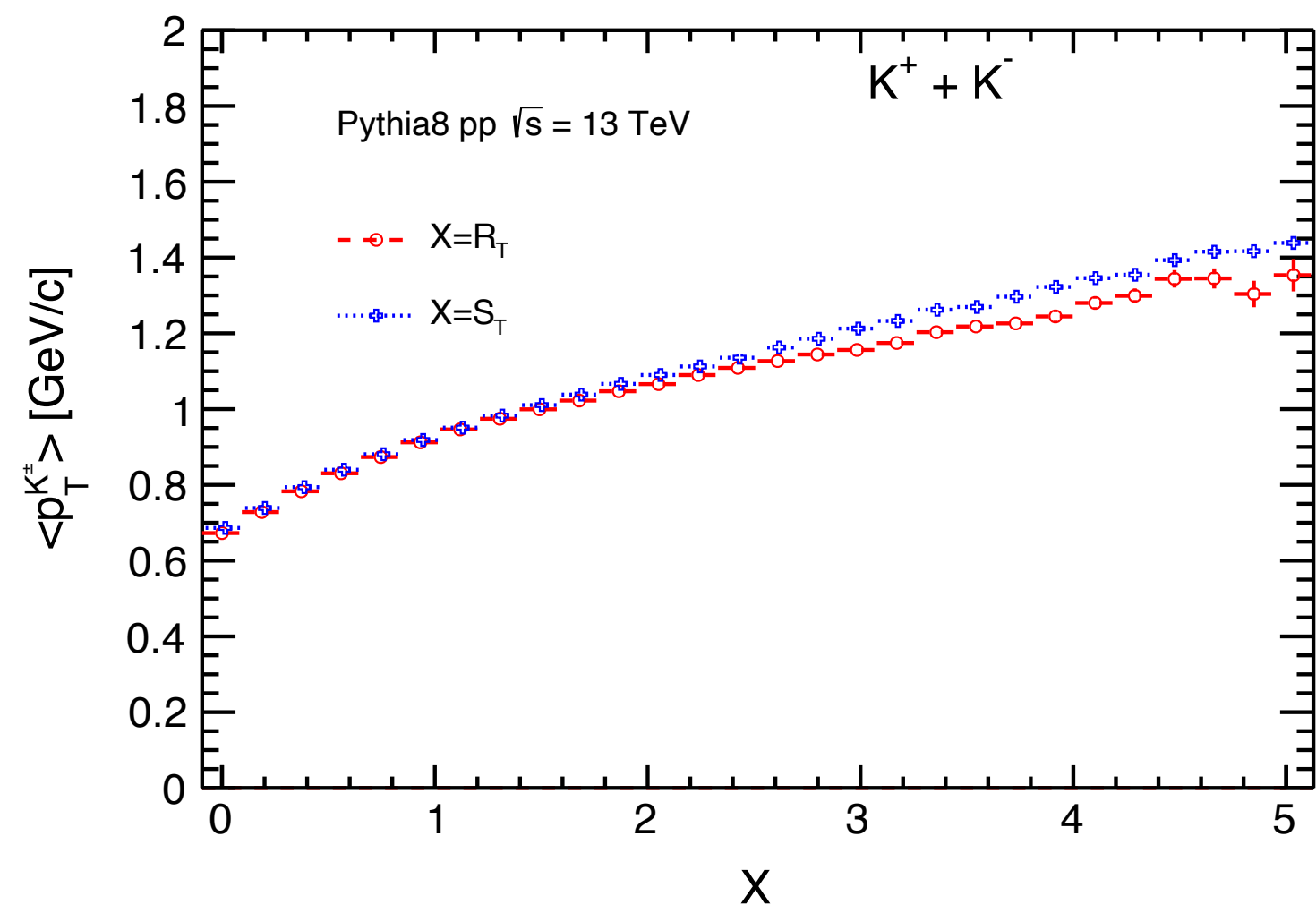
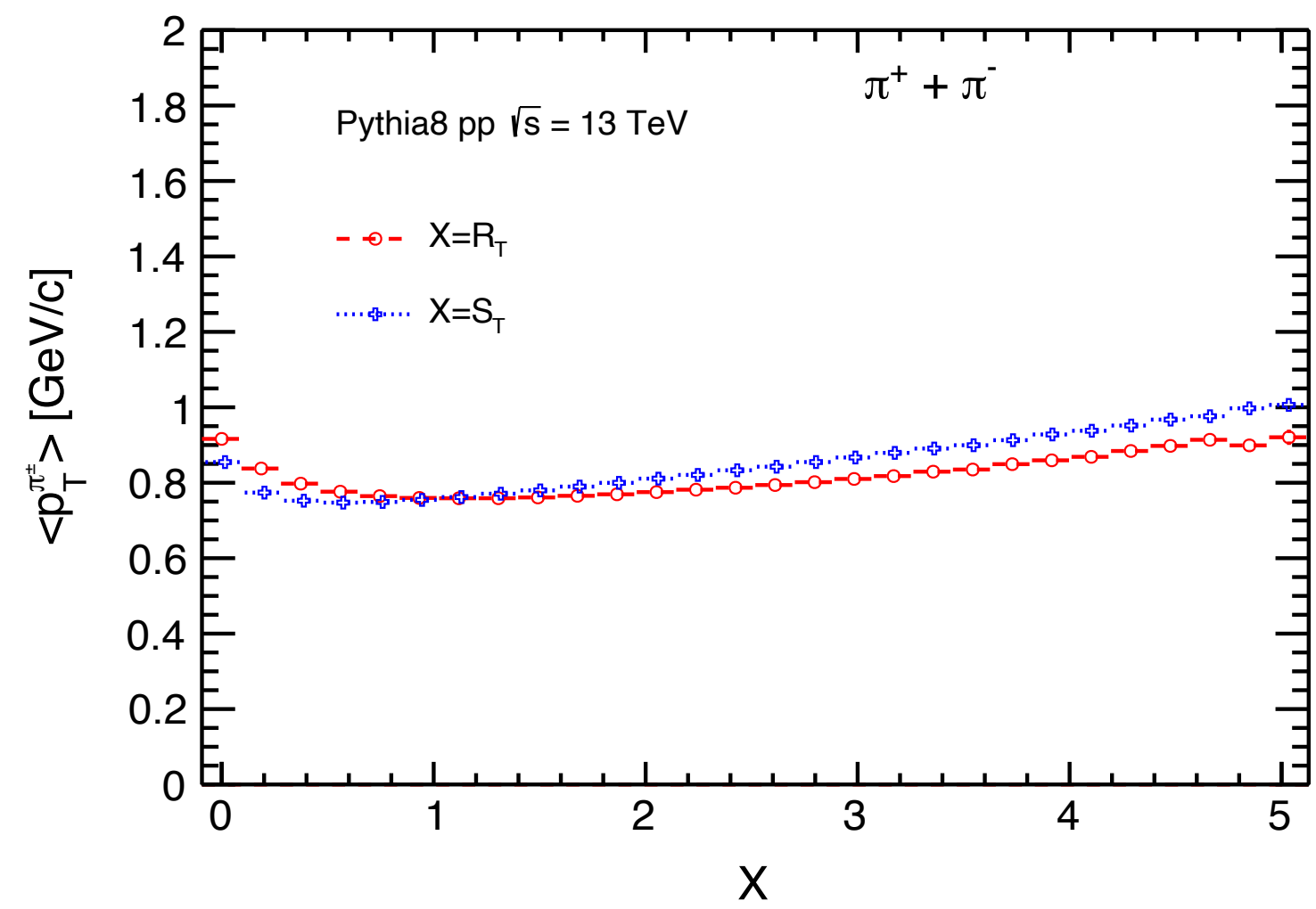
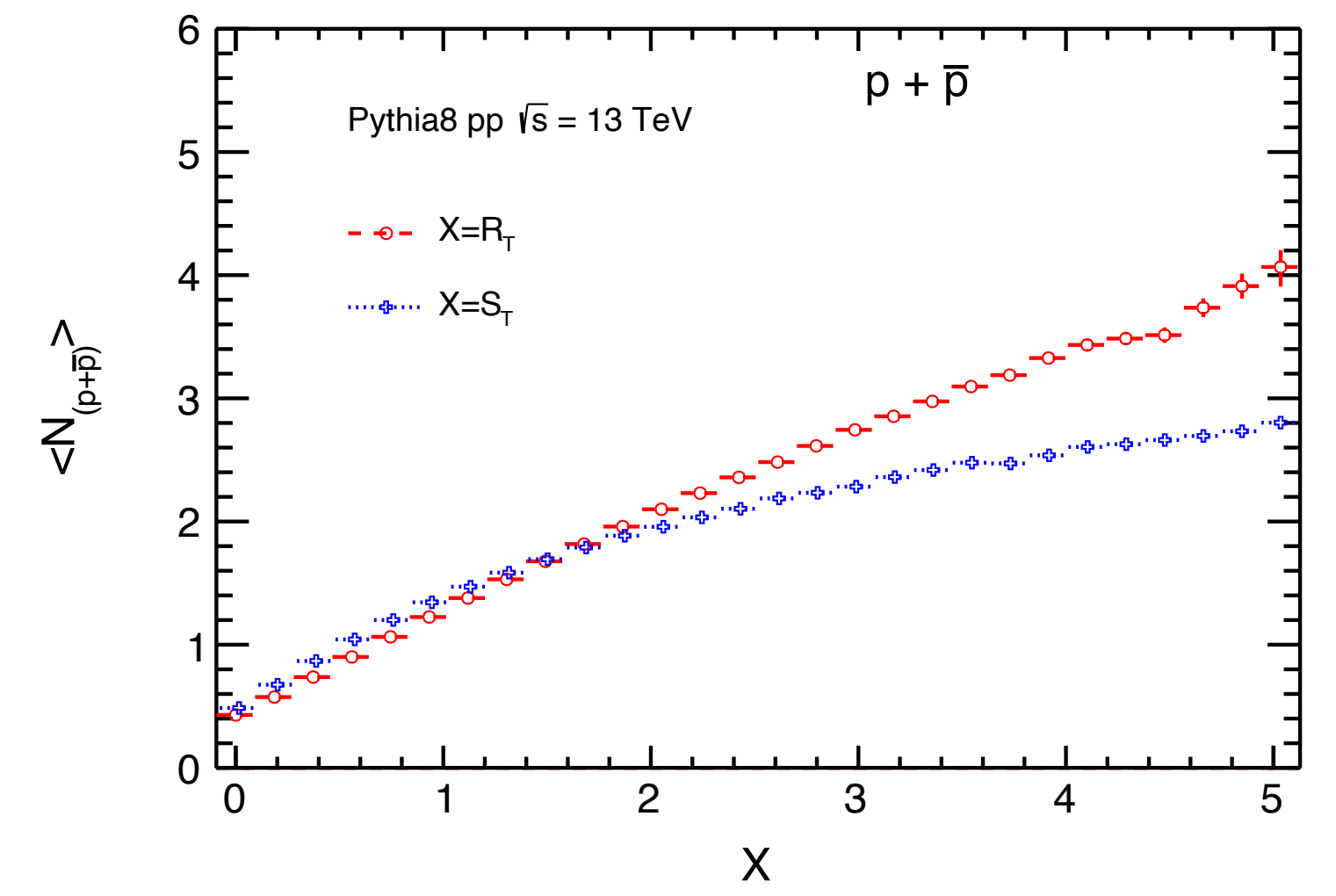
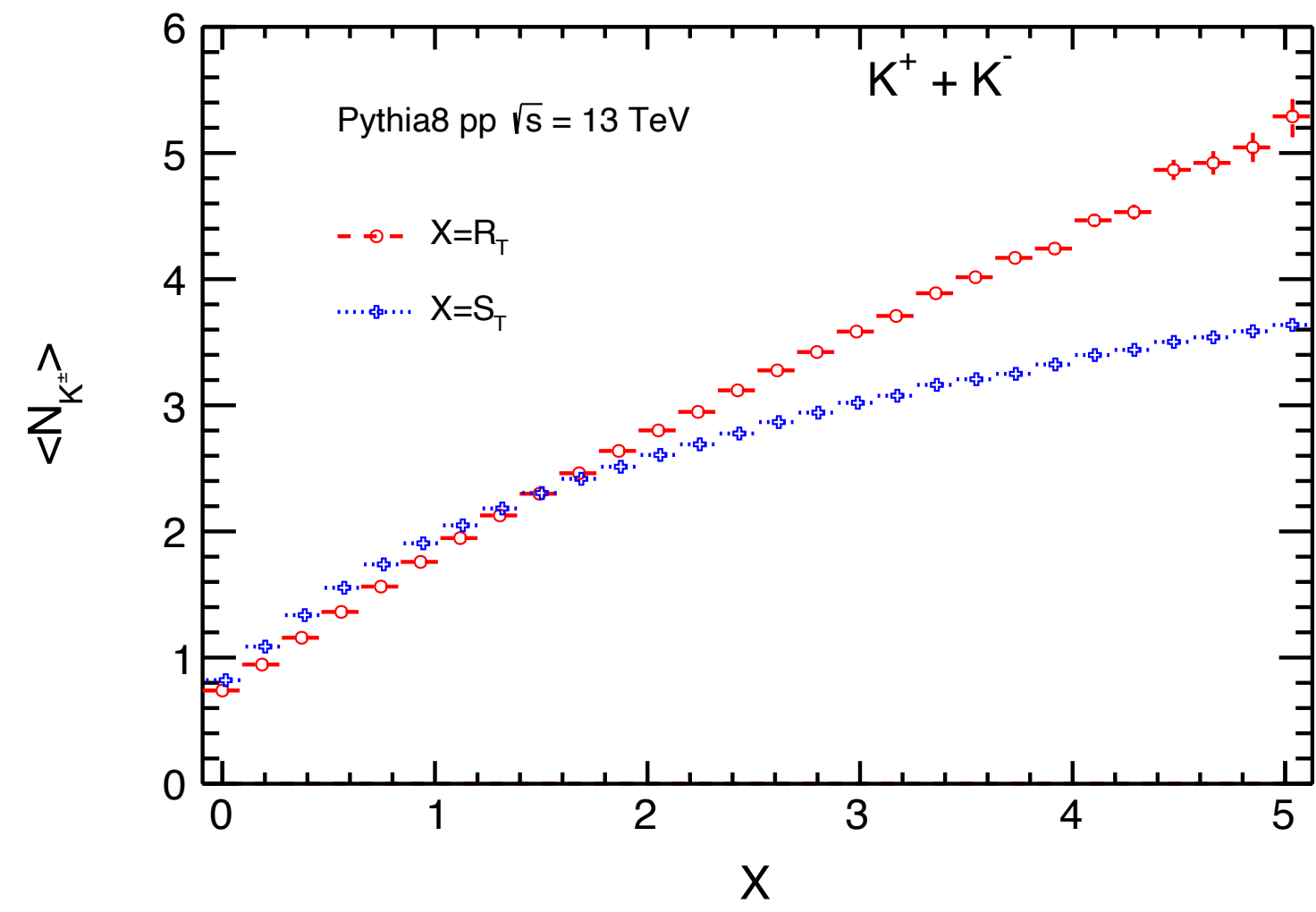
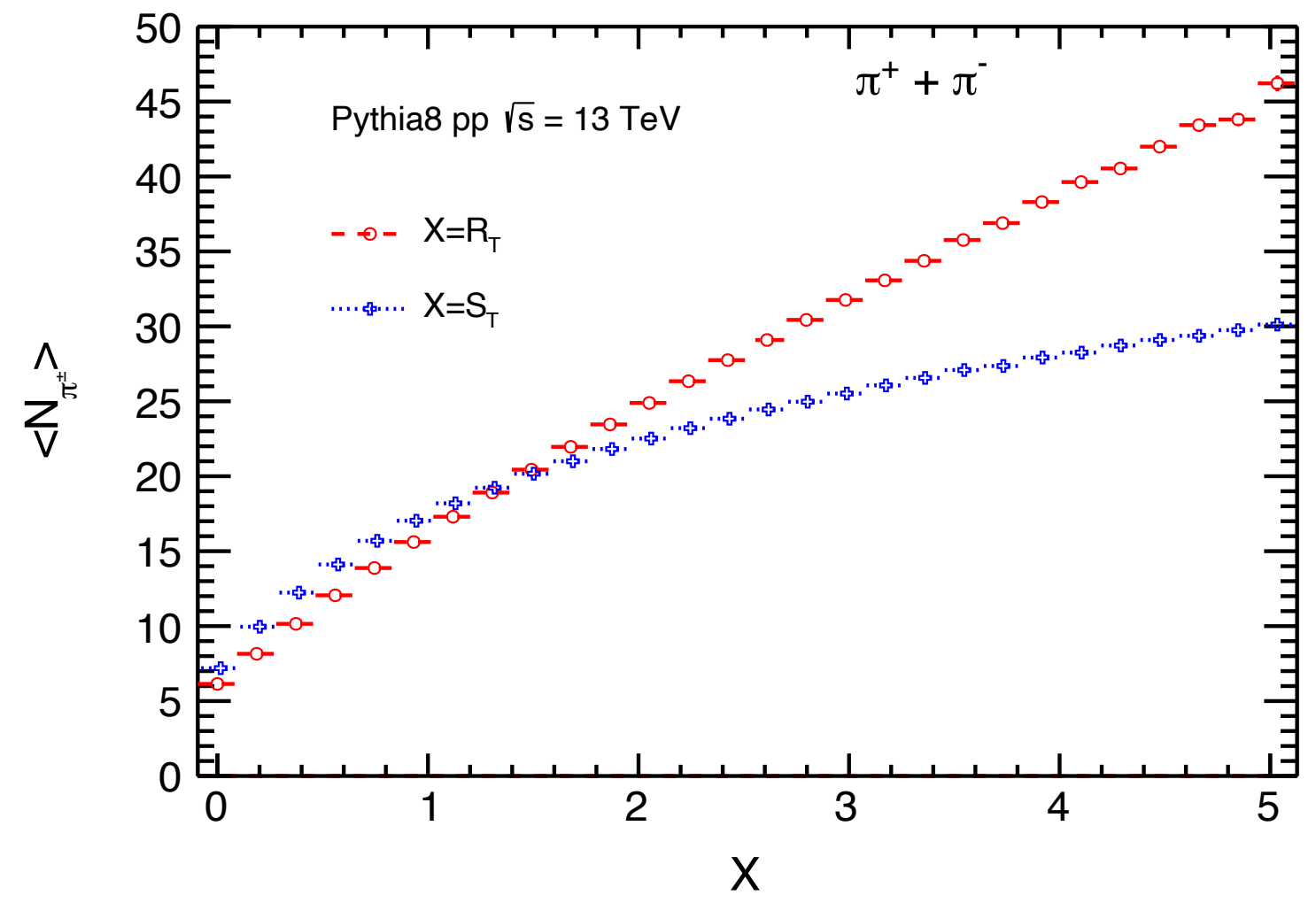
Distribution of $\langle N_{ch} \rangle$ and $\langle p_T \rangle$



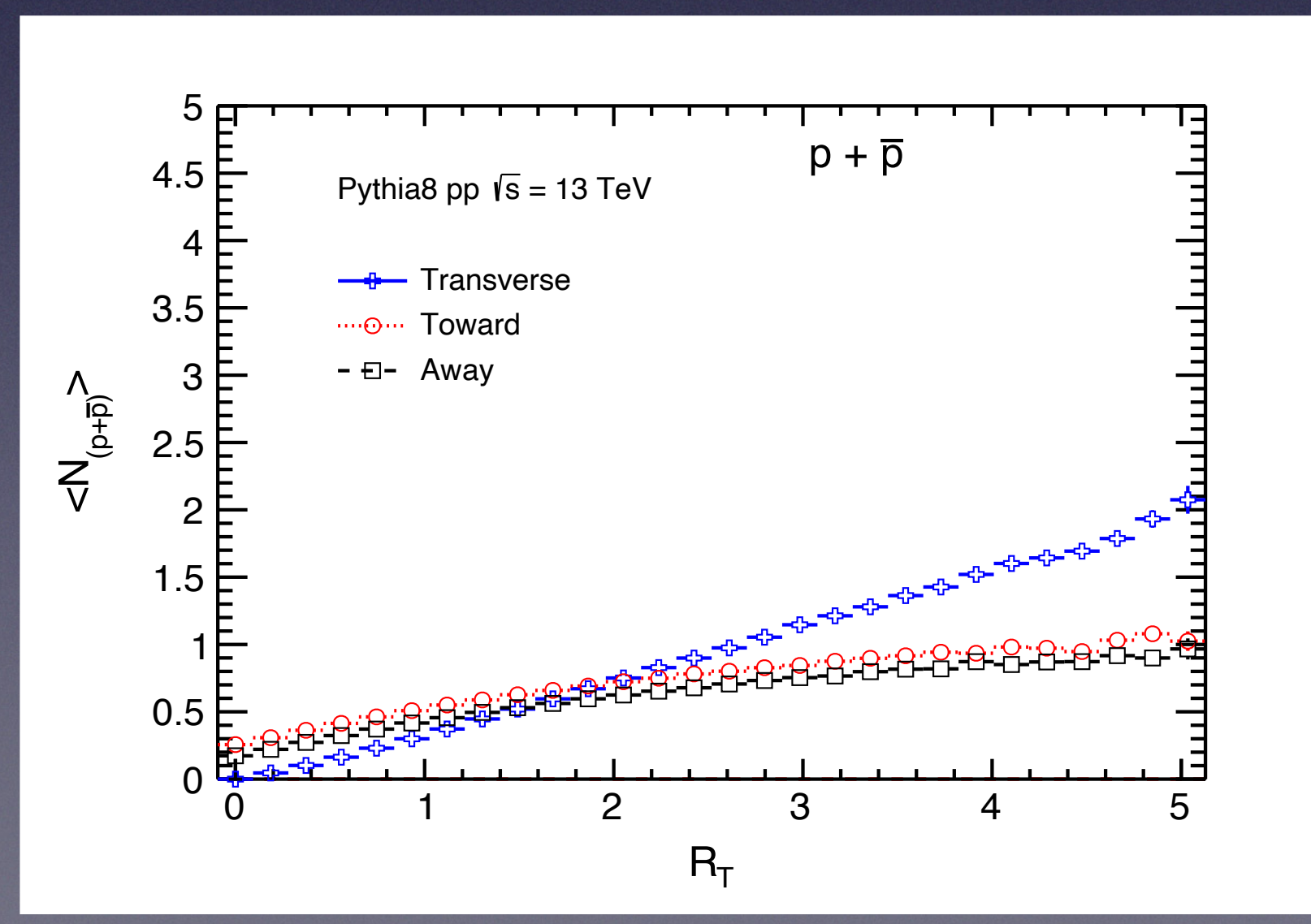
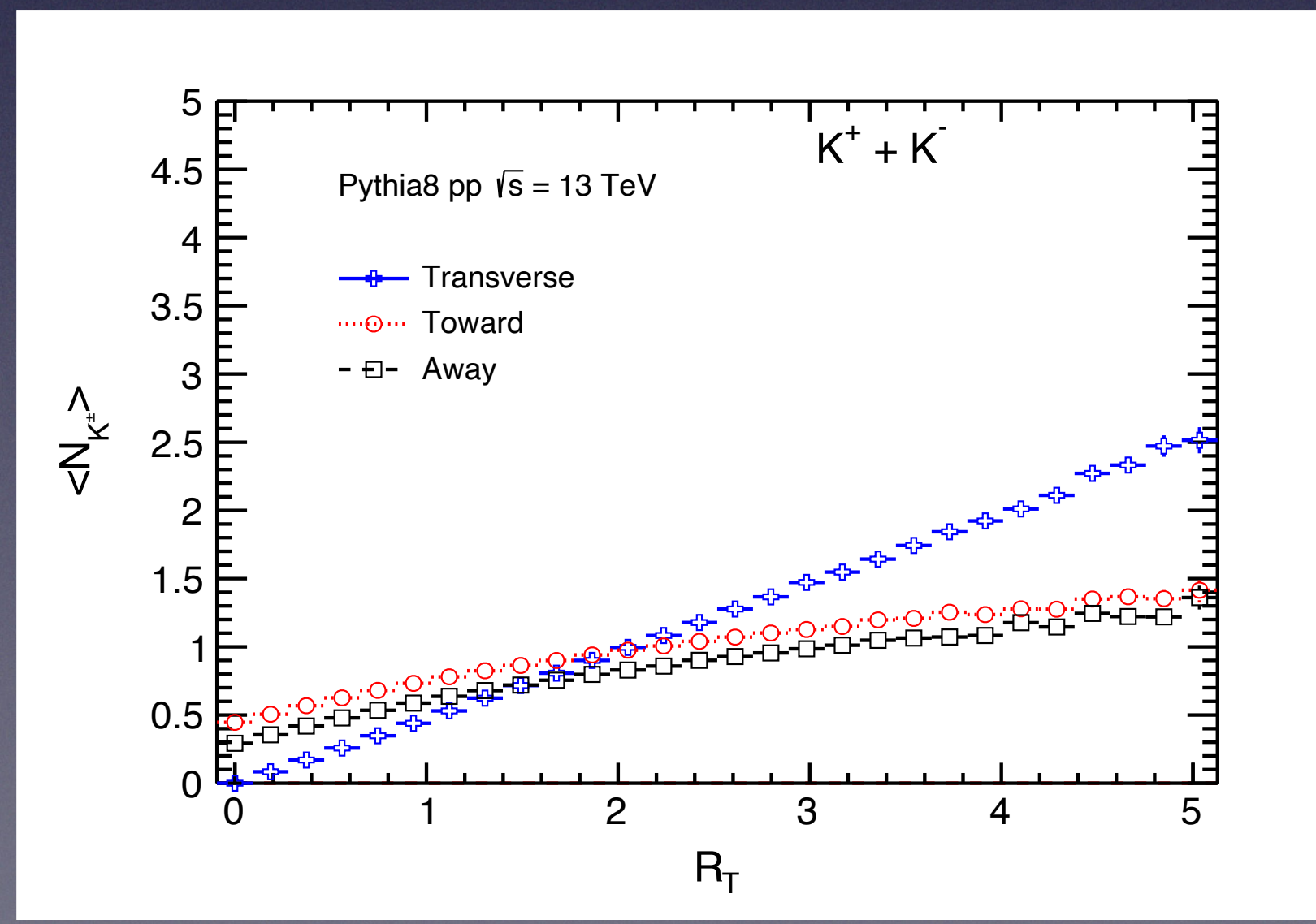
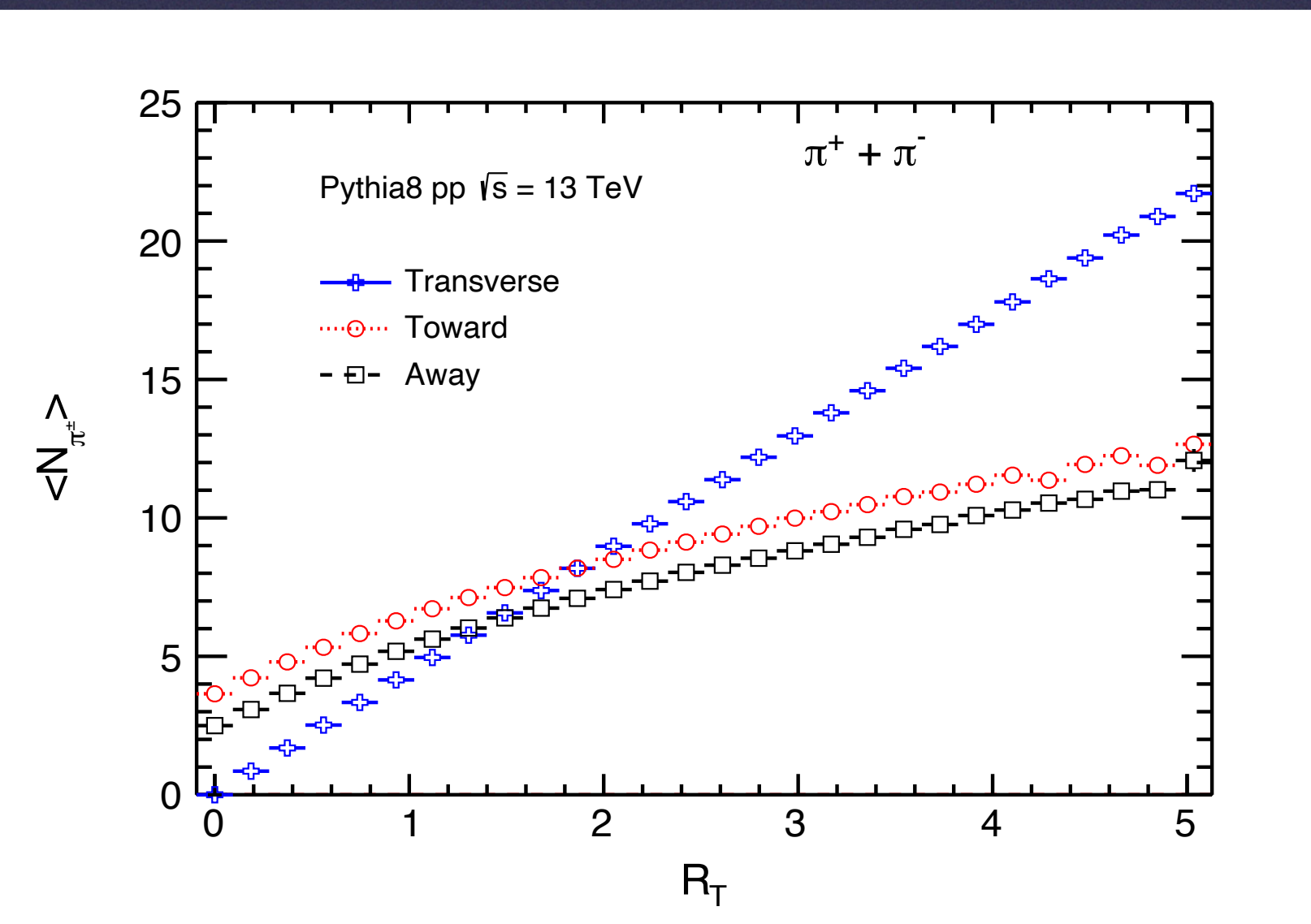
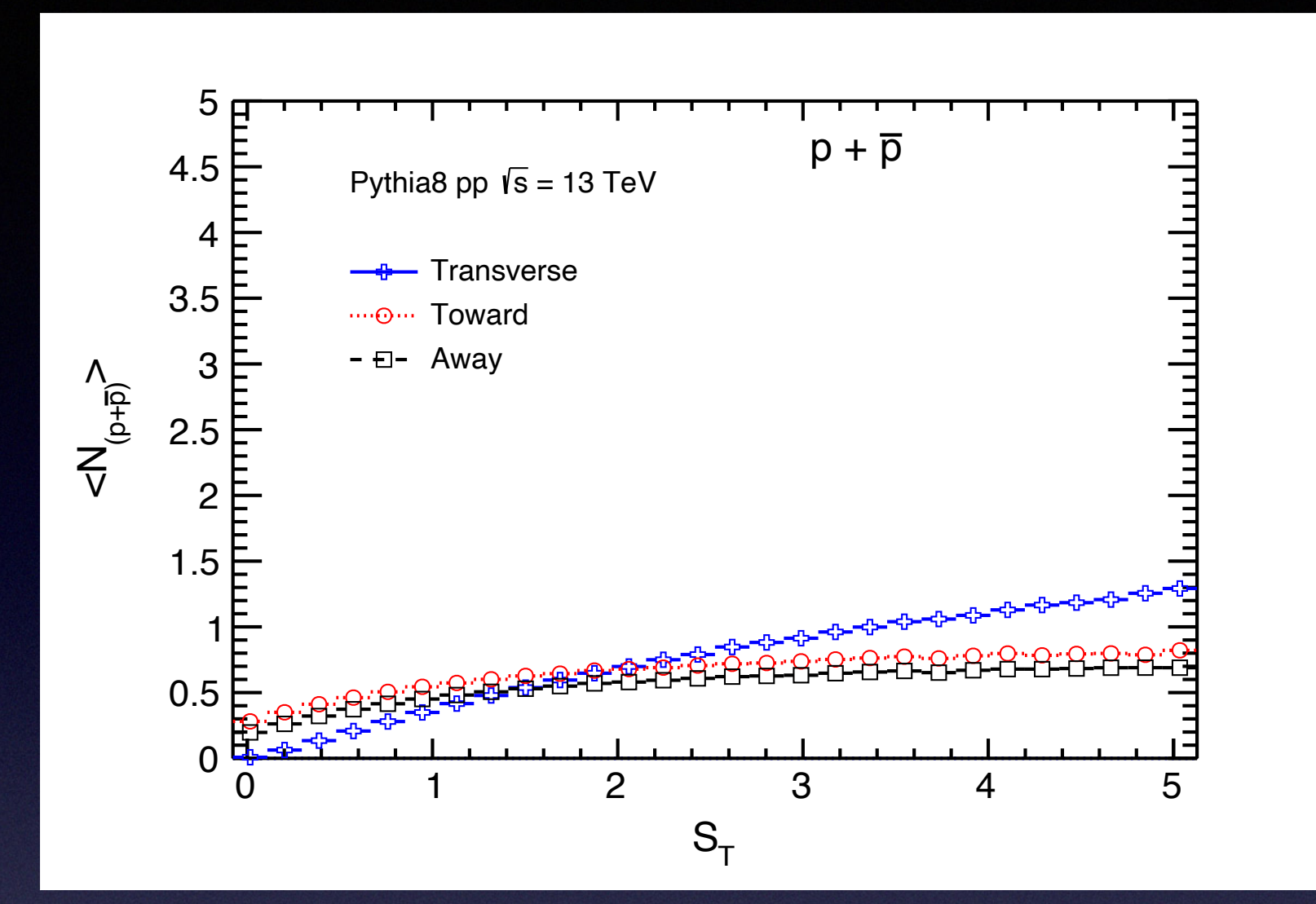
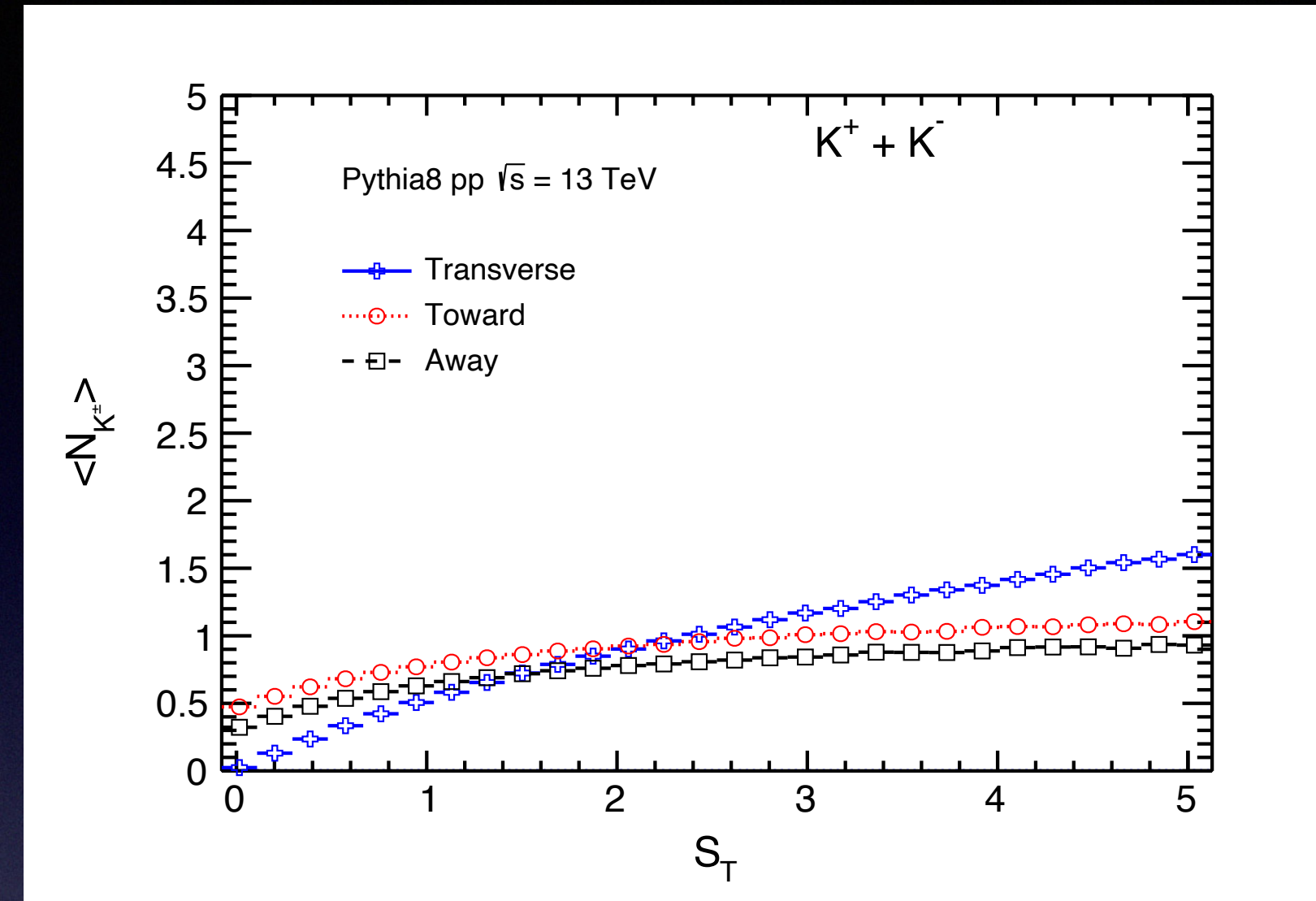
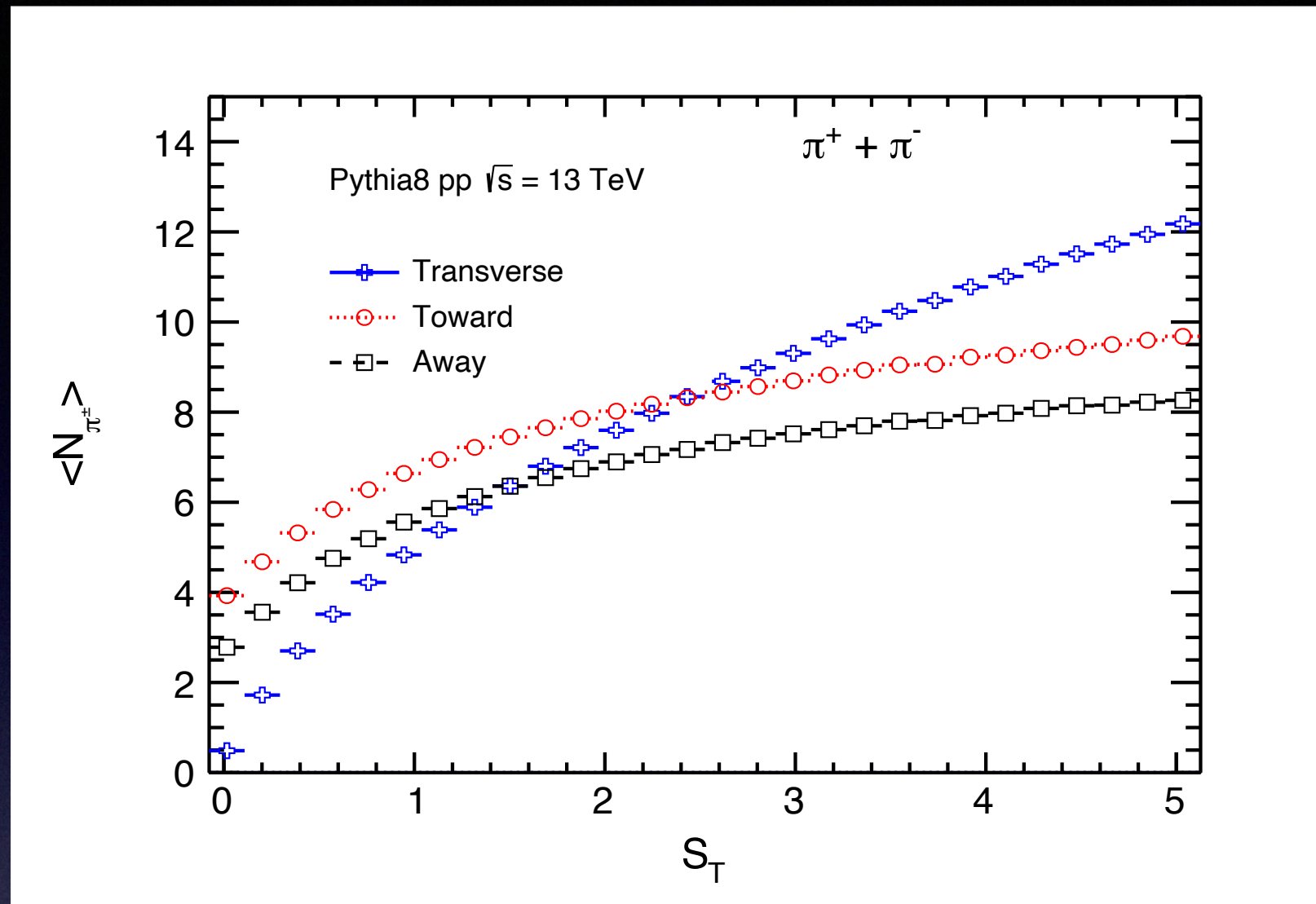
Identified Particles : Pions, Kaons and Protons



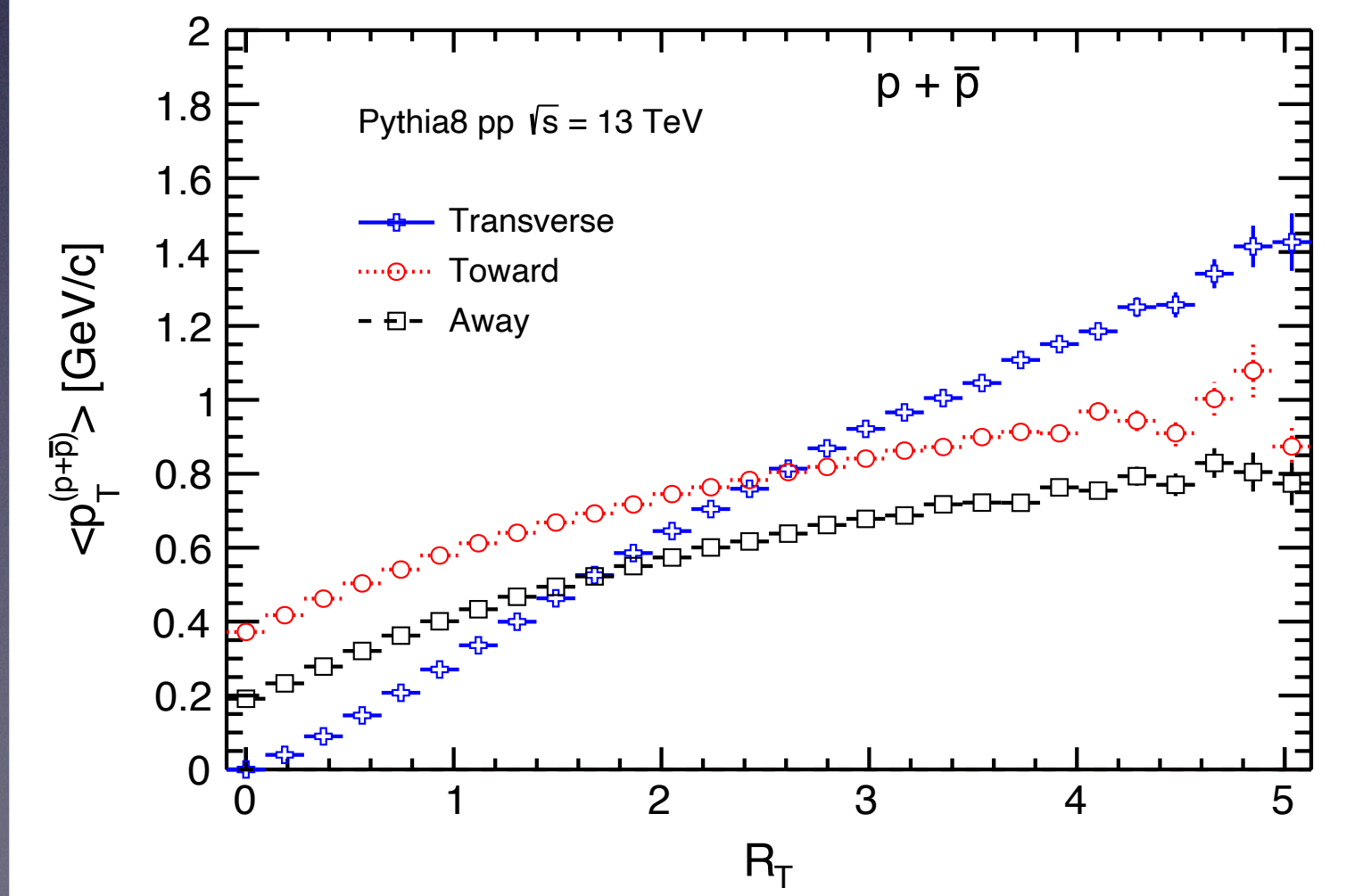
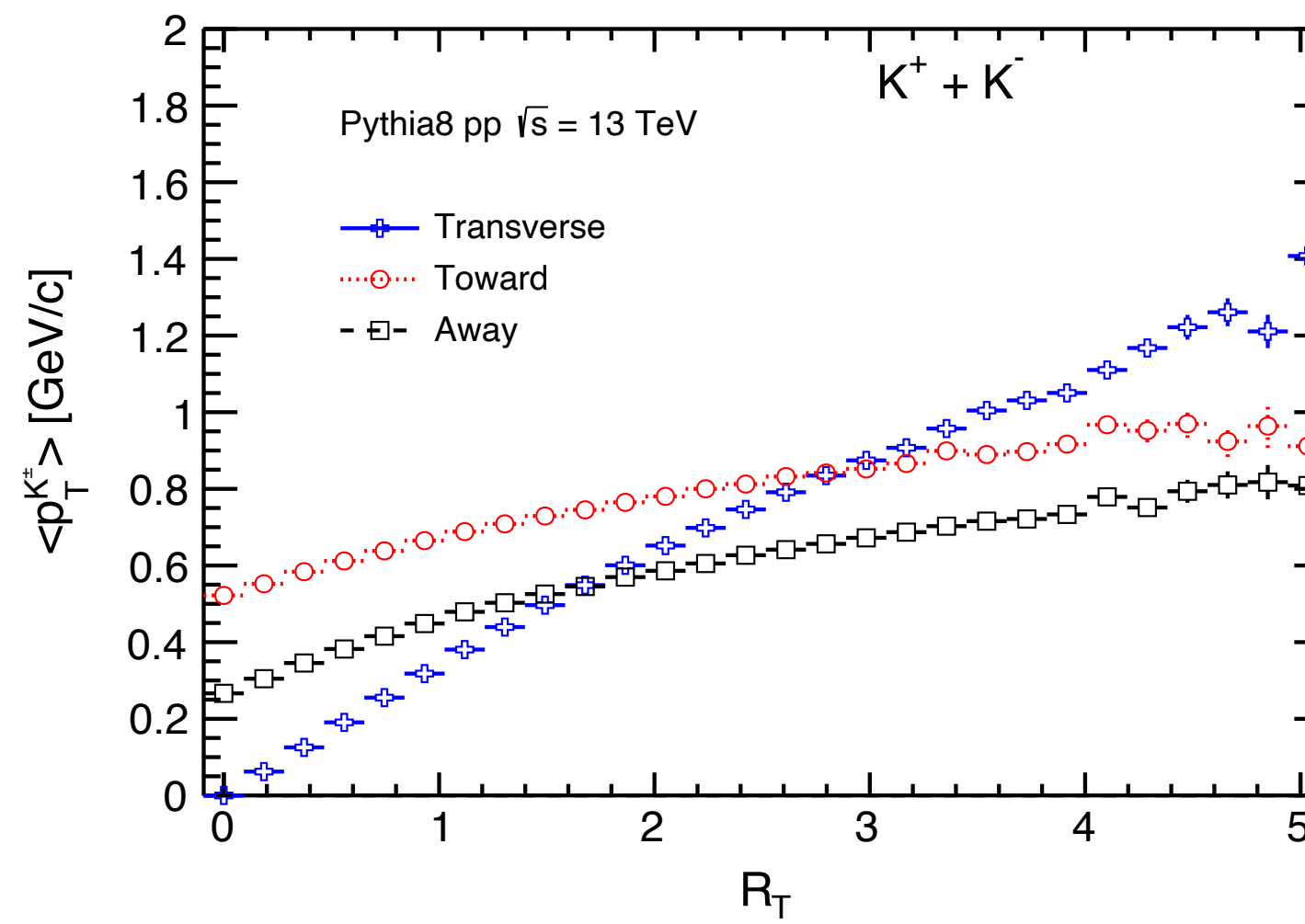
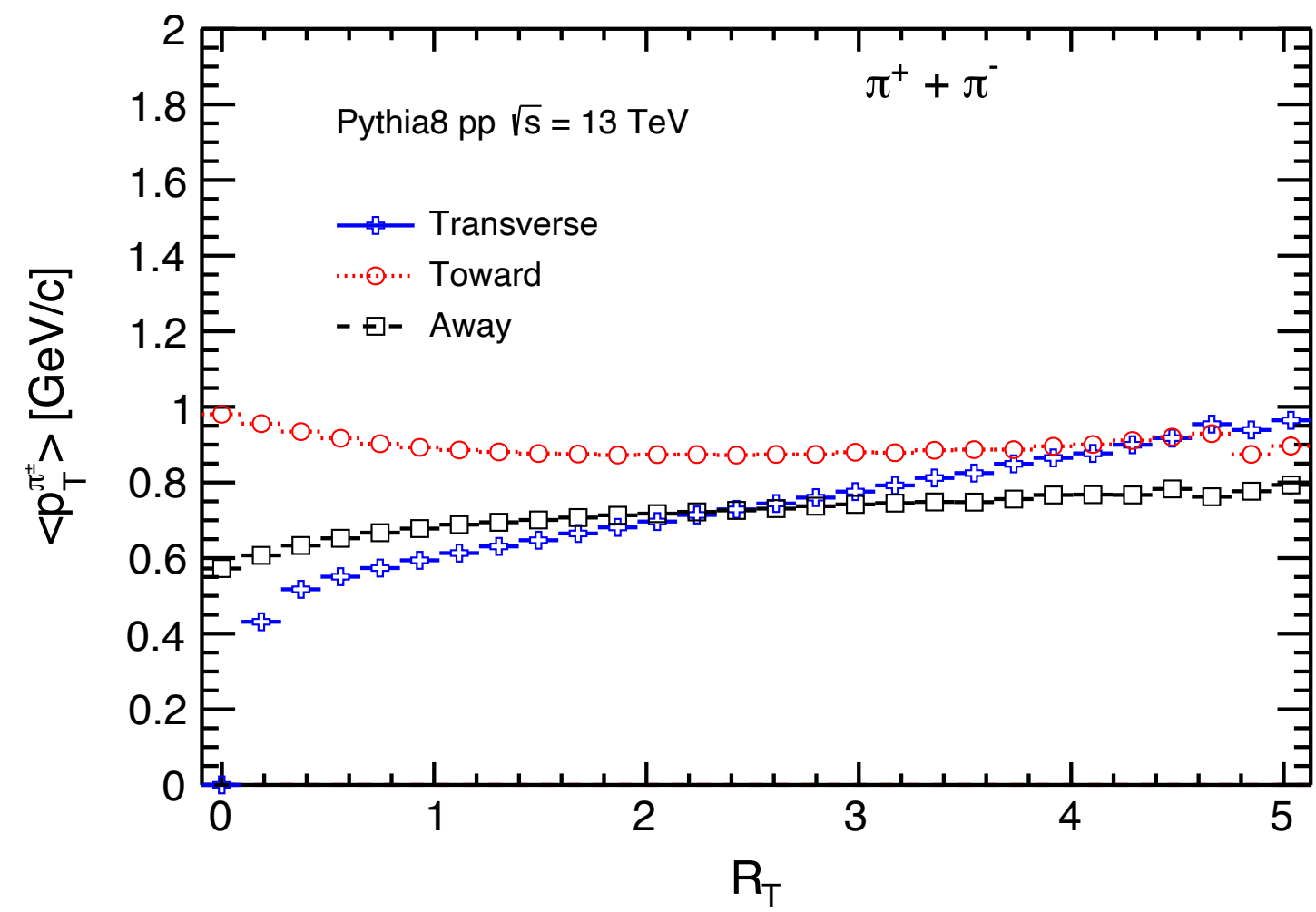
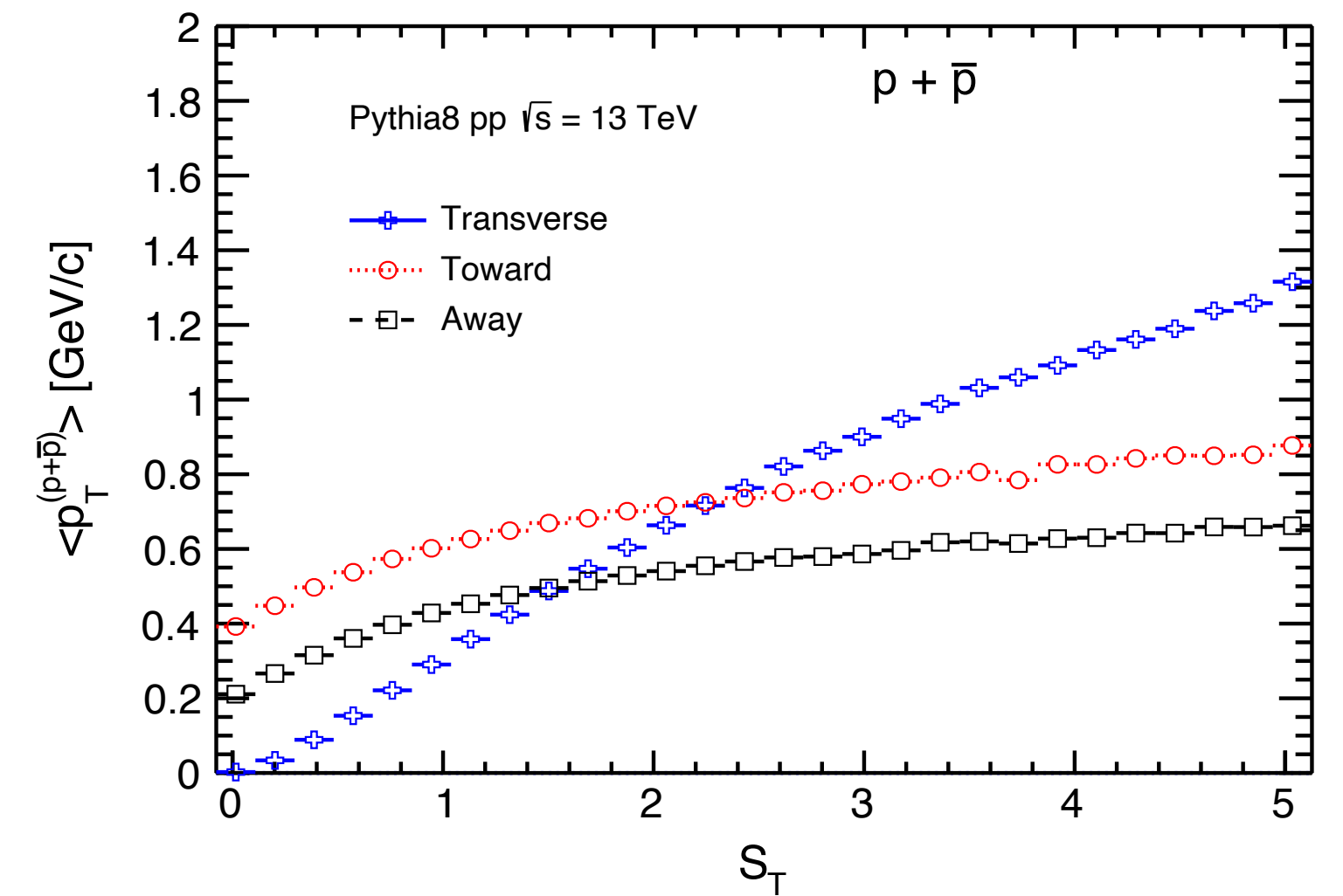
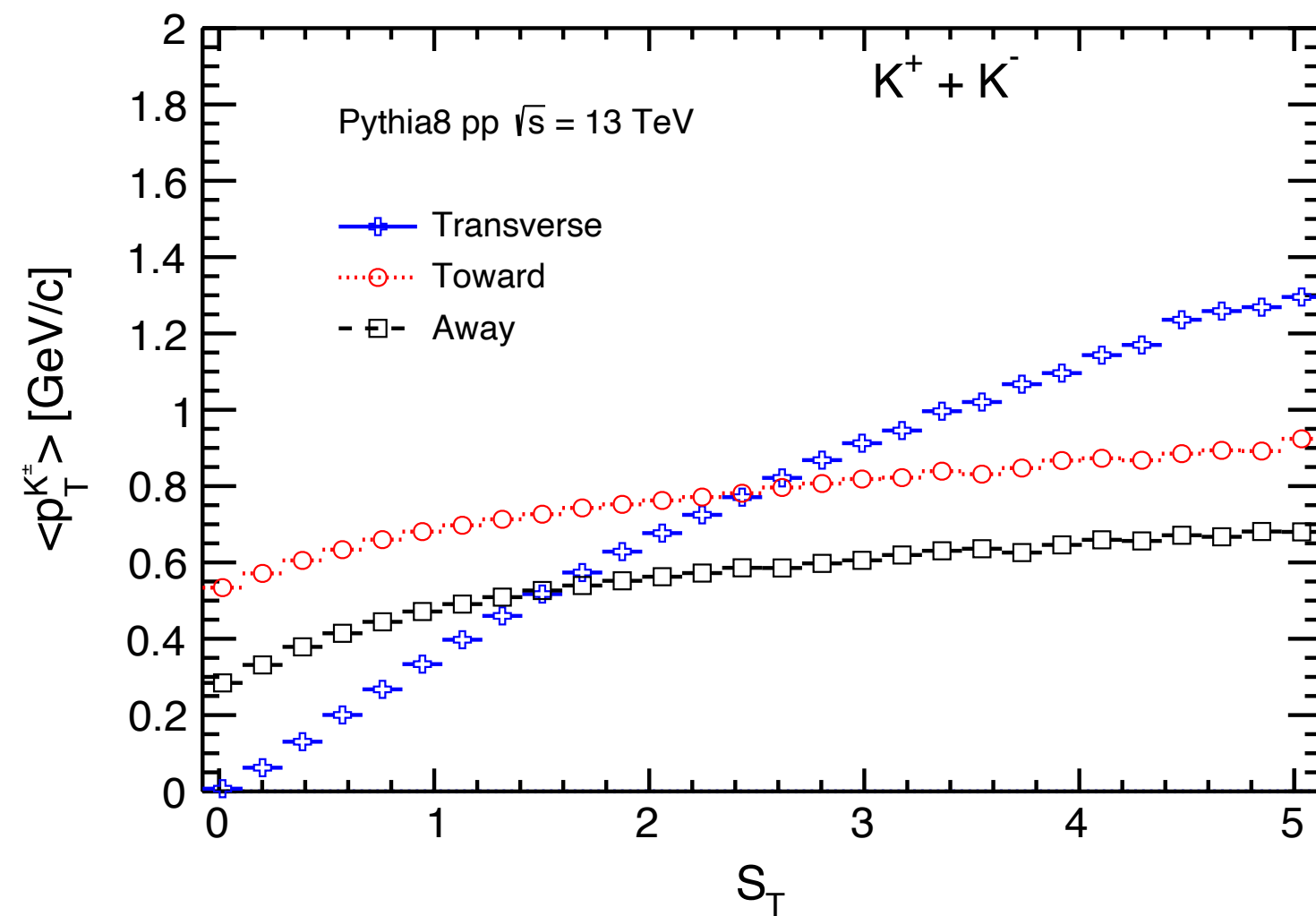
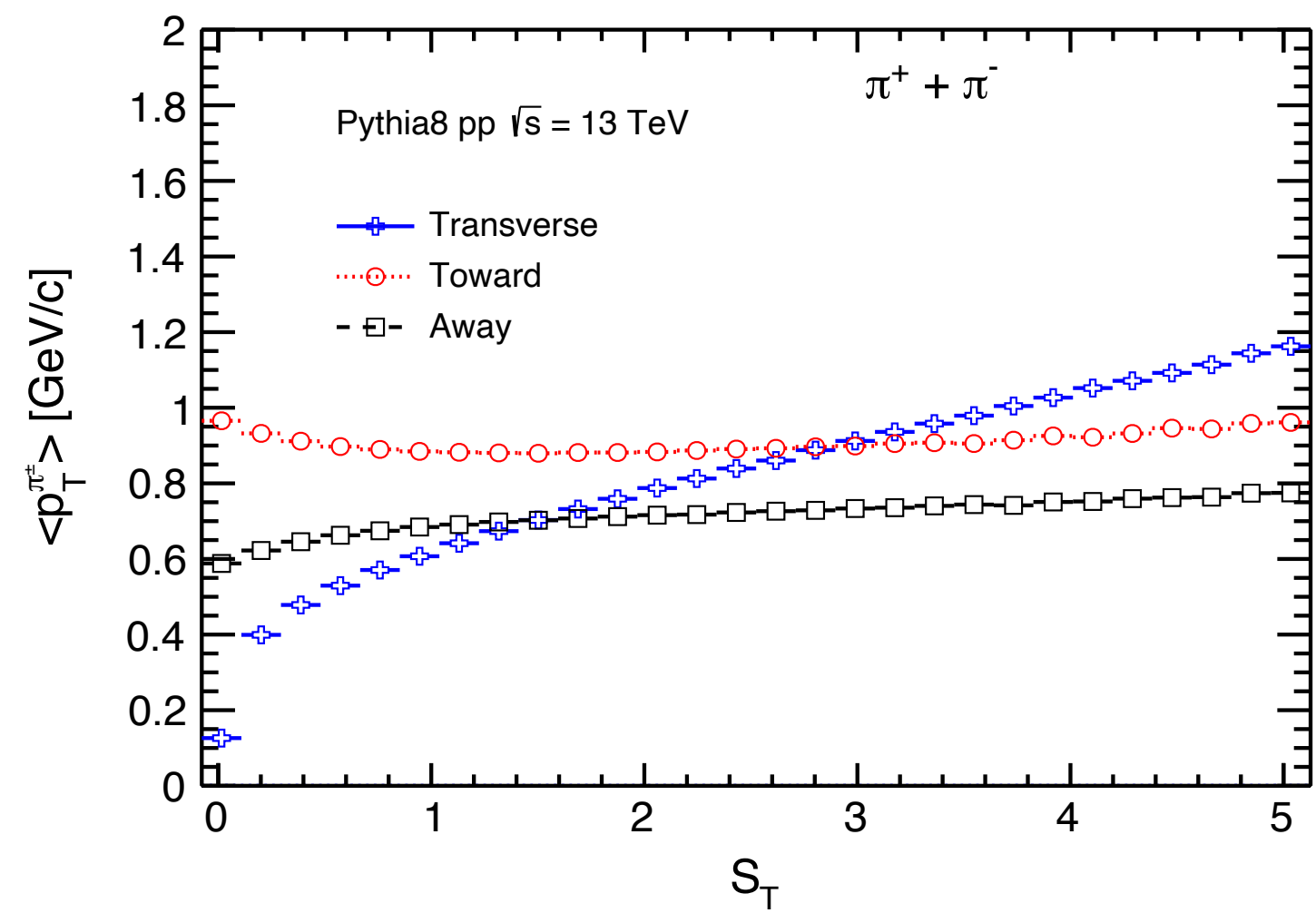
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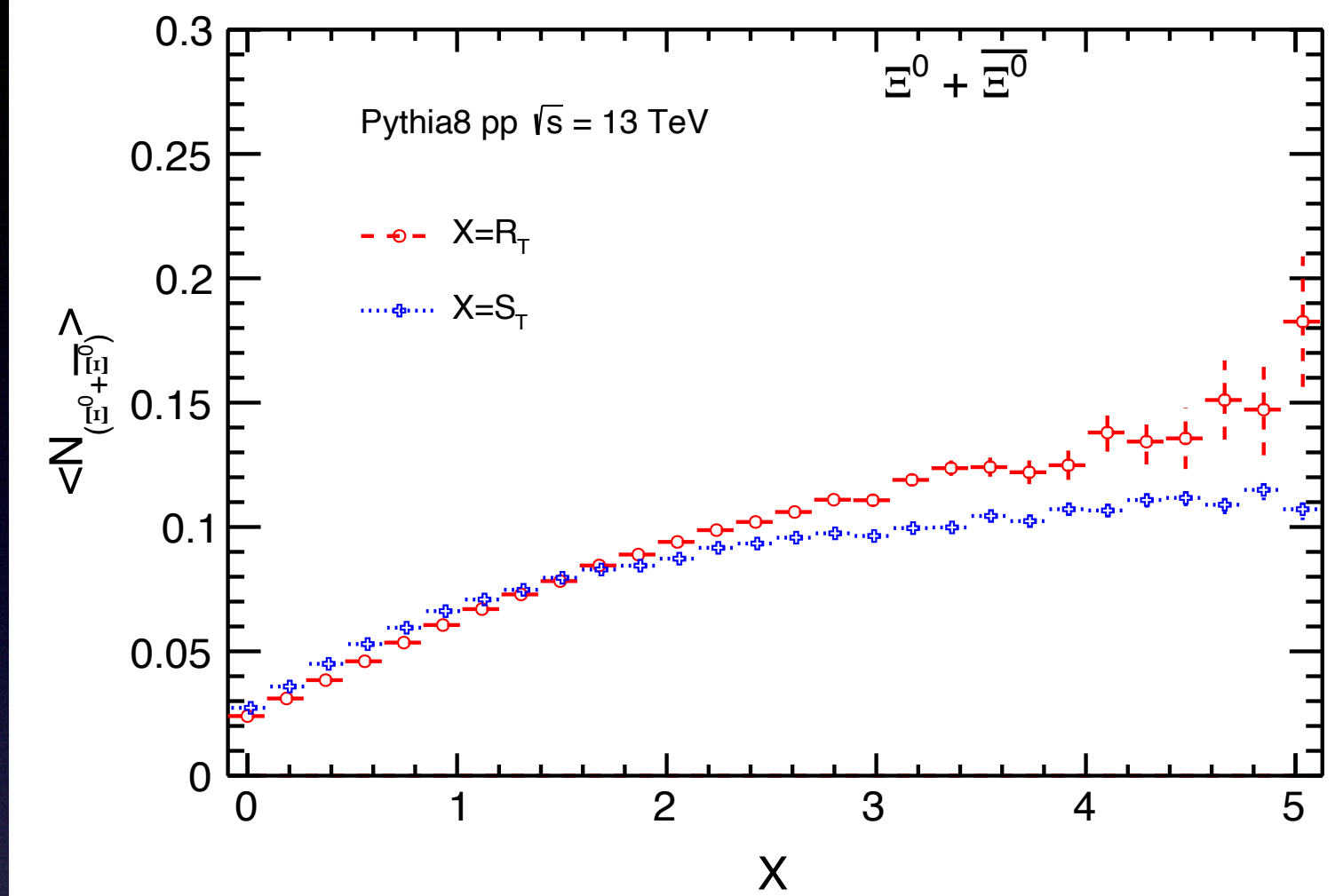
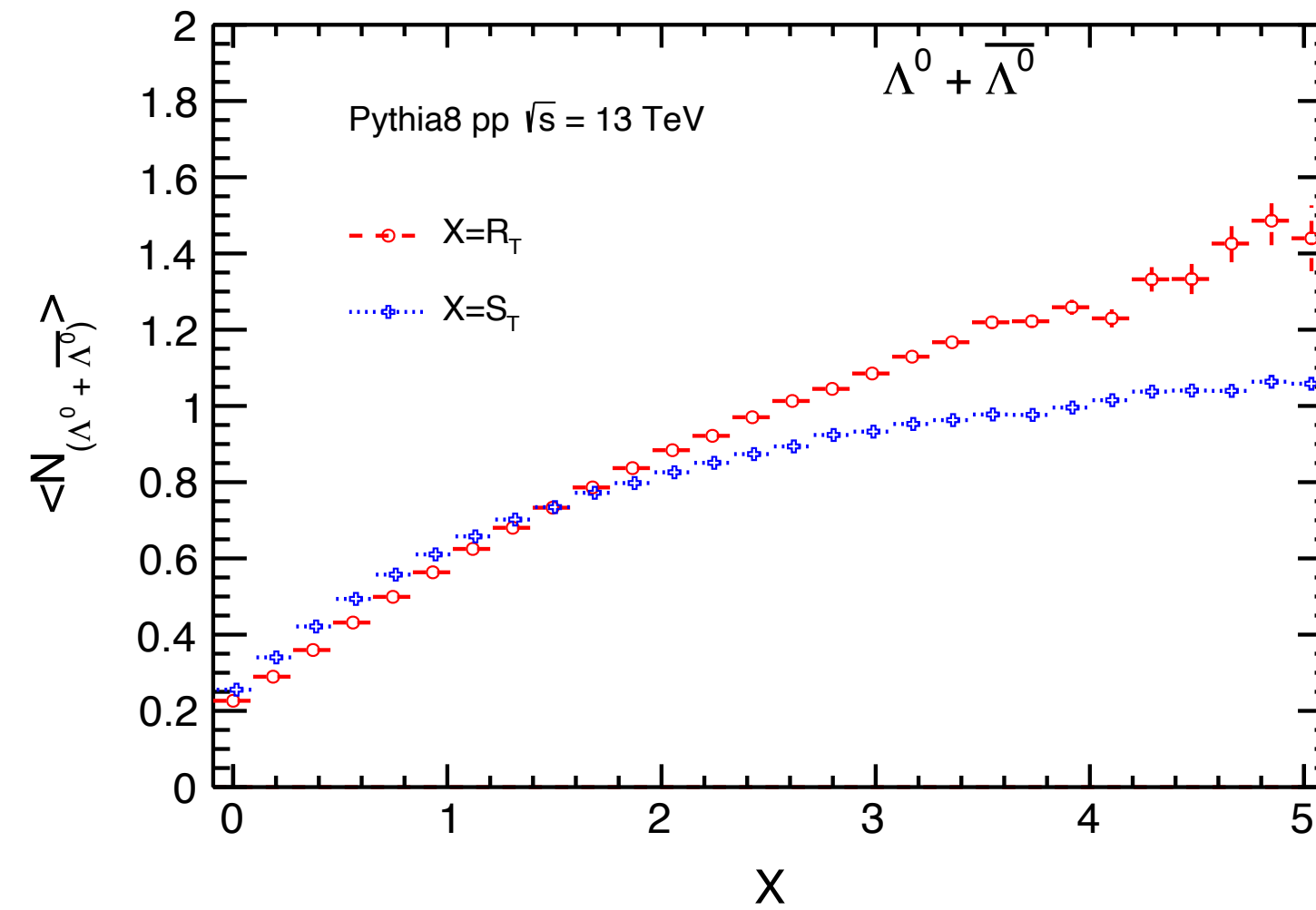
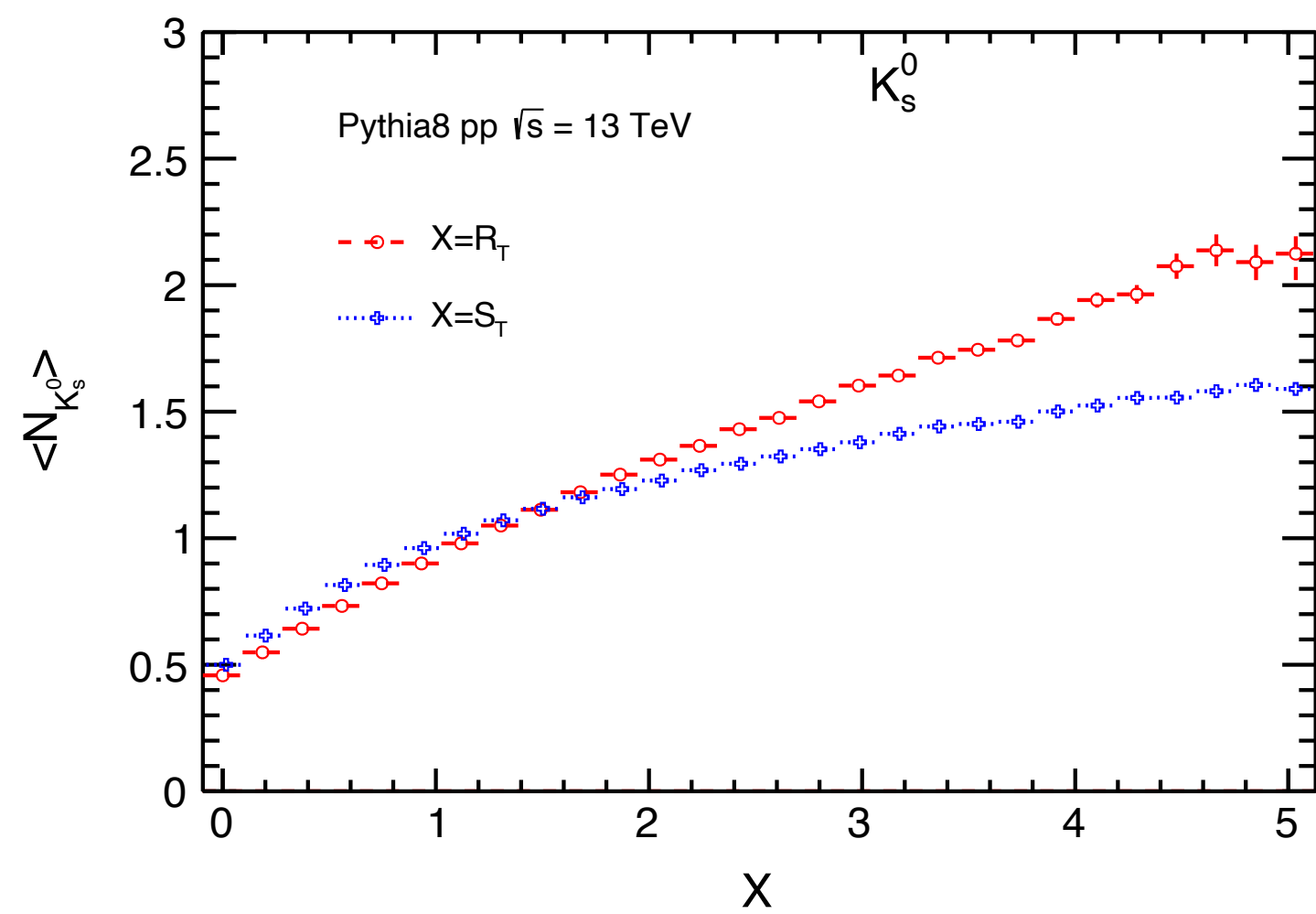
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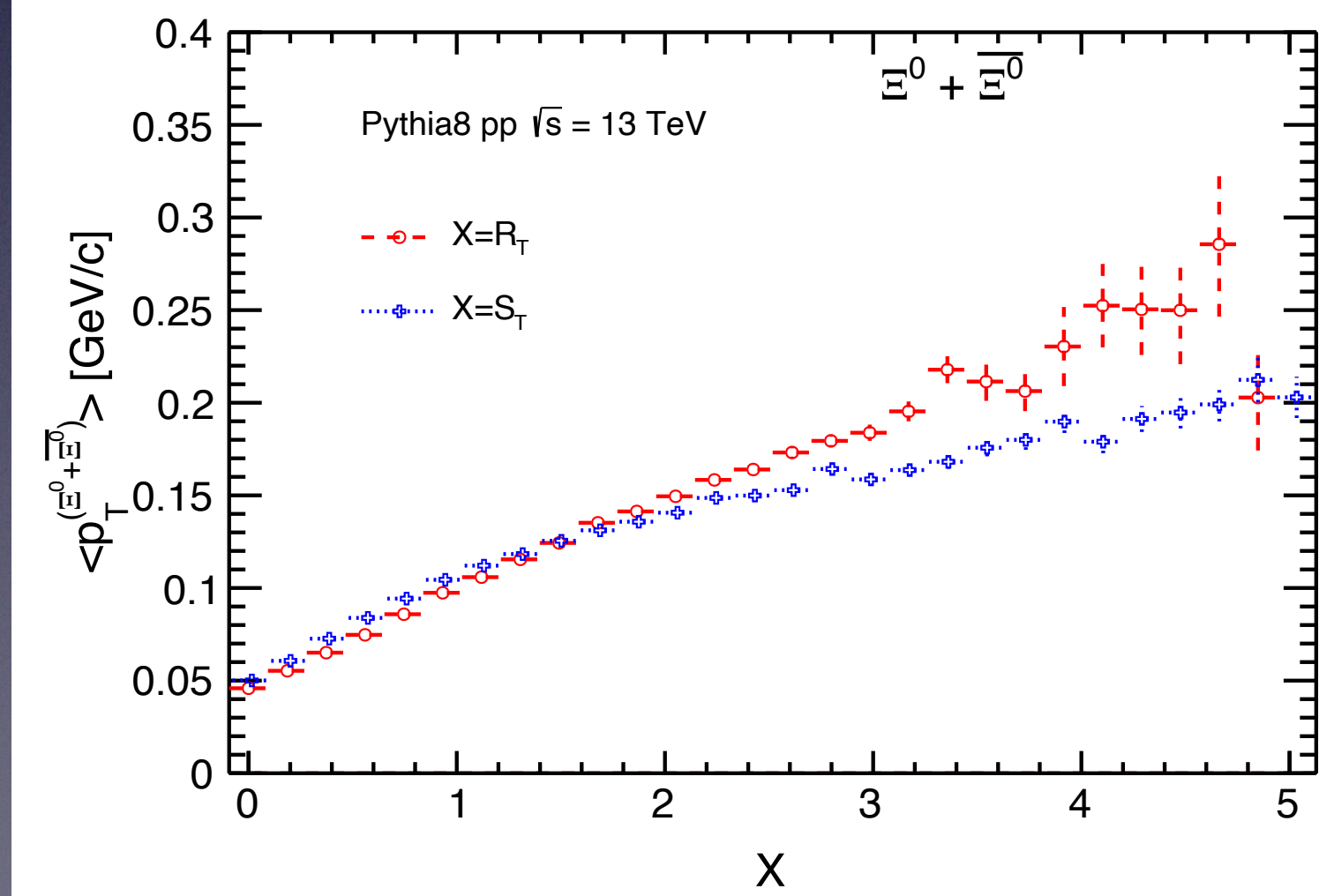
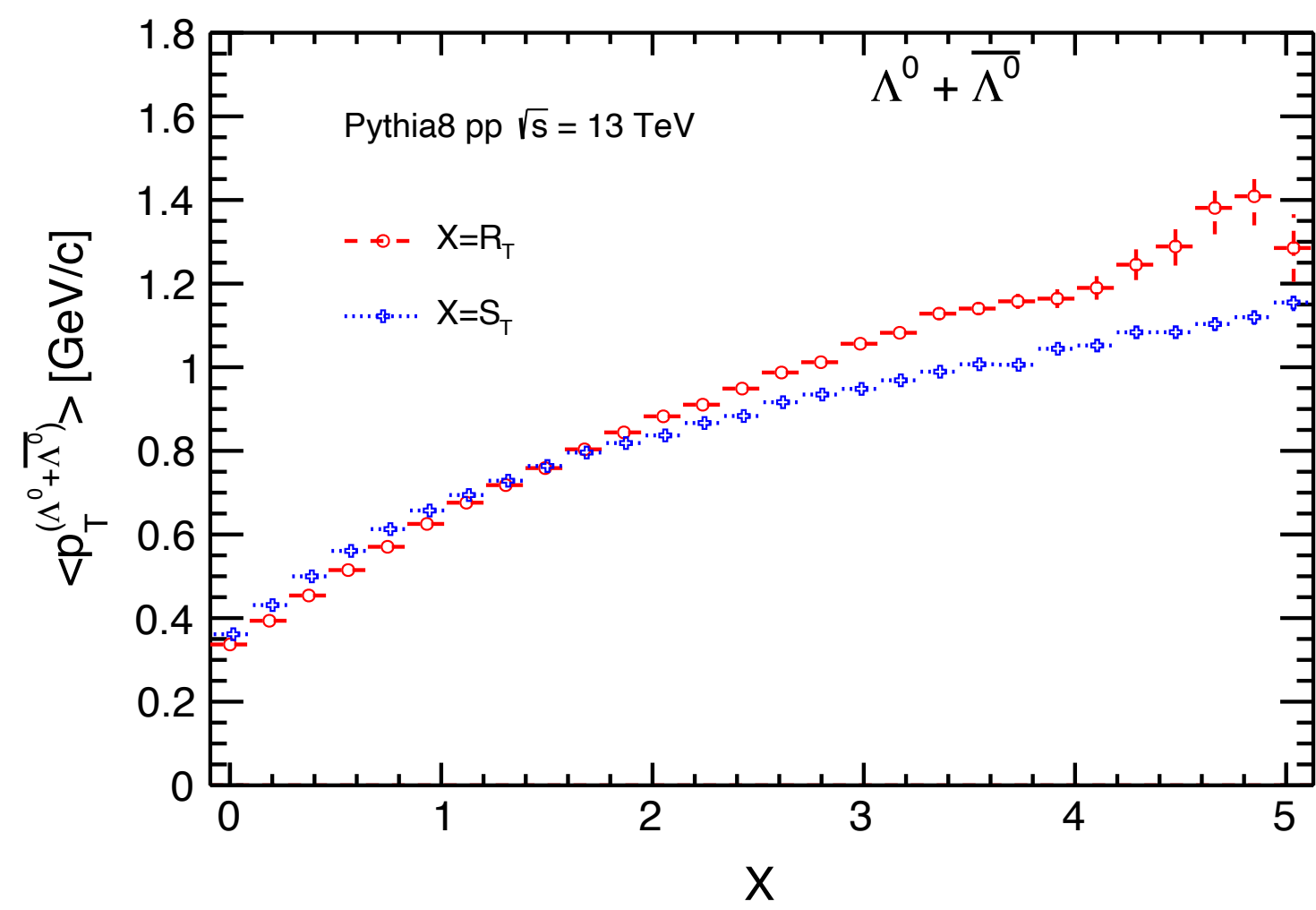
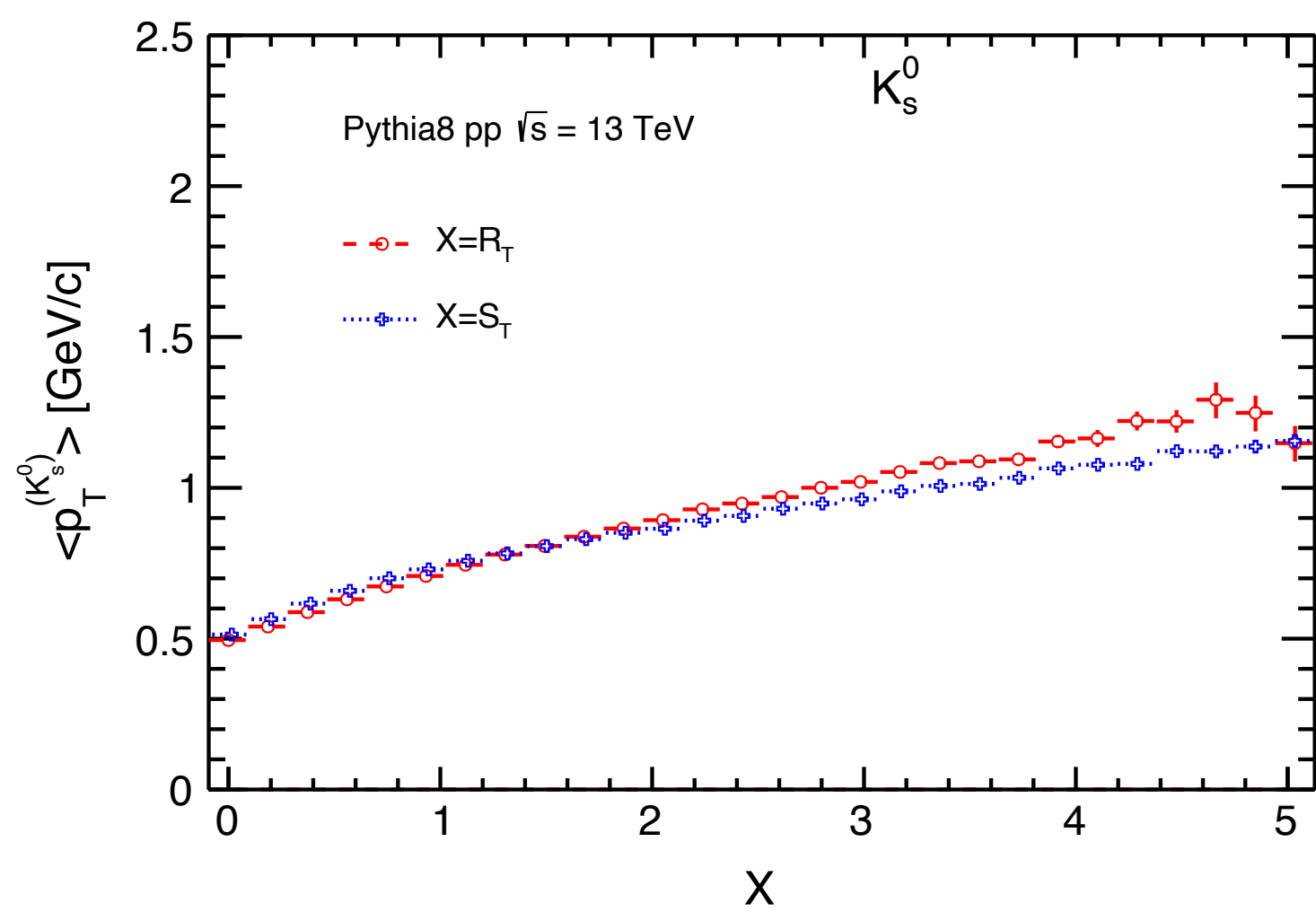
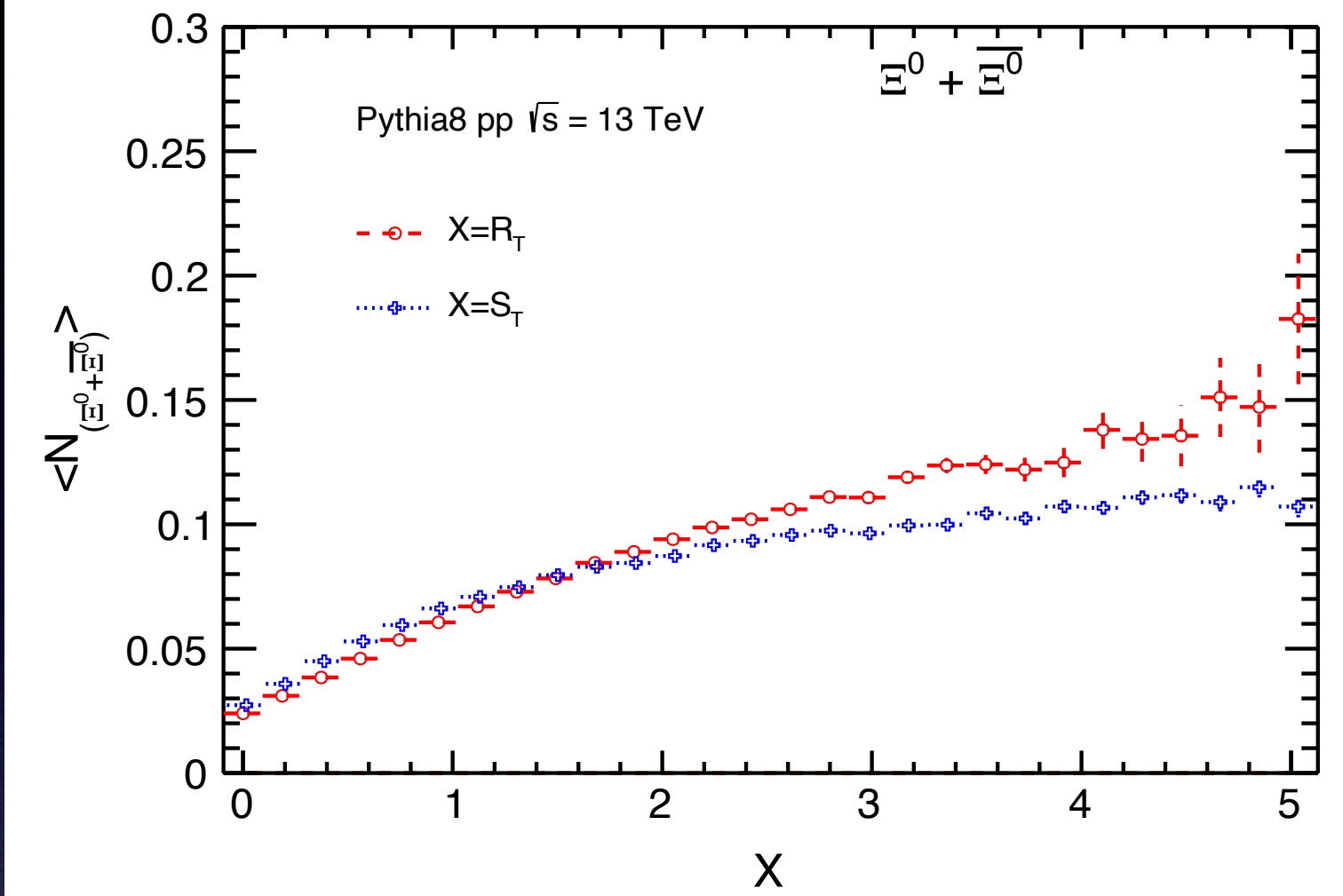
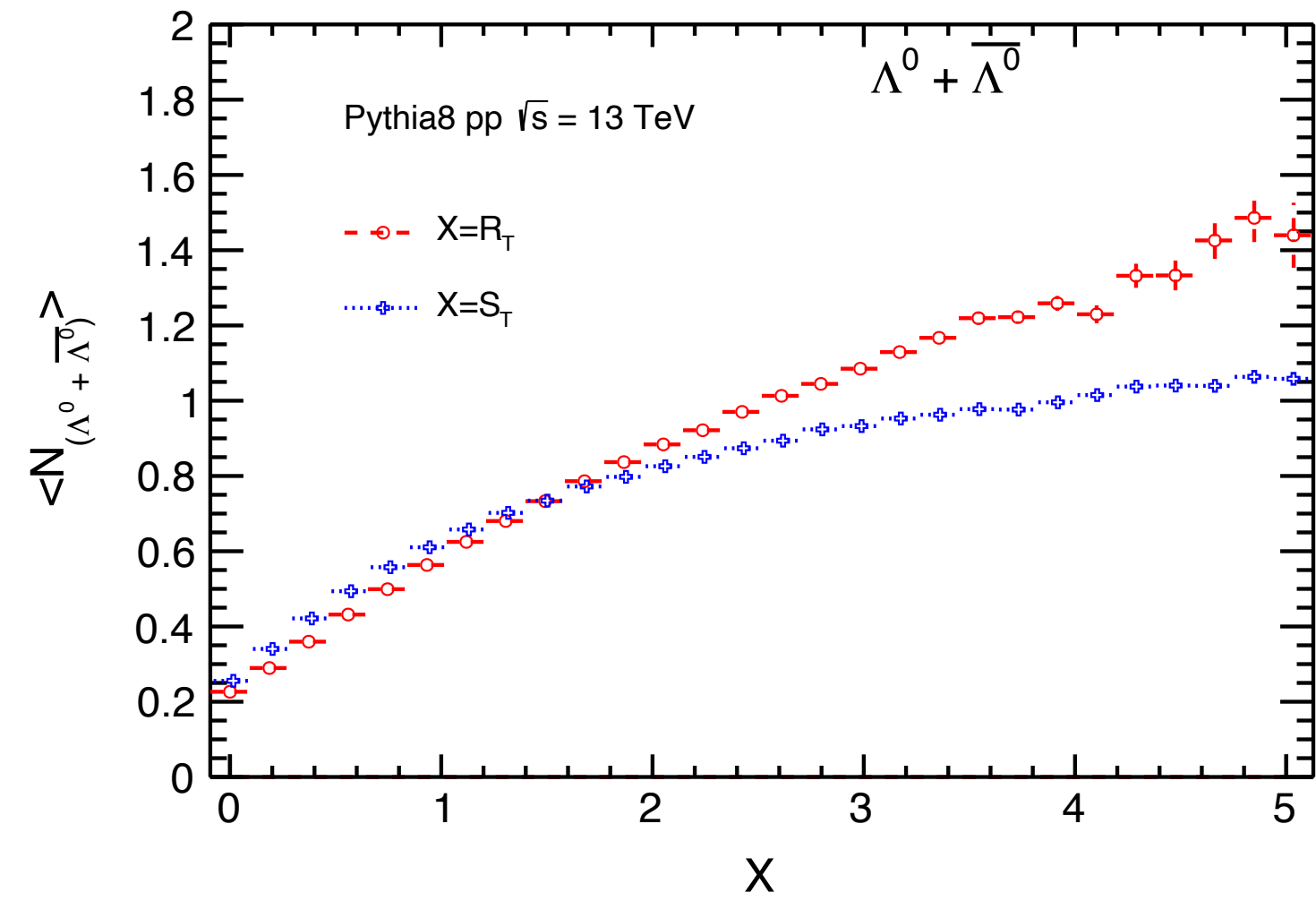
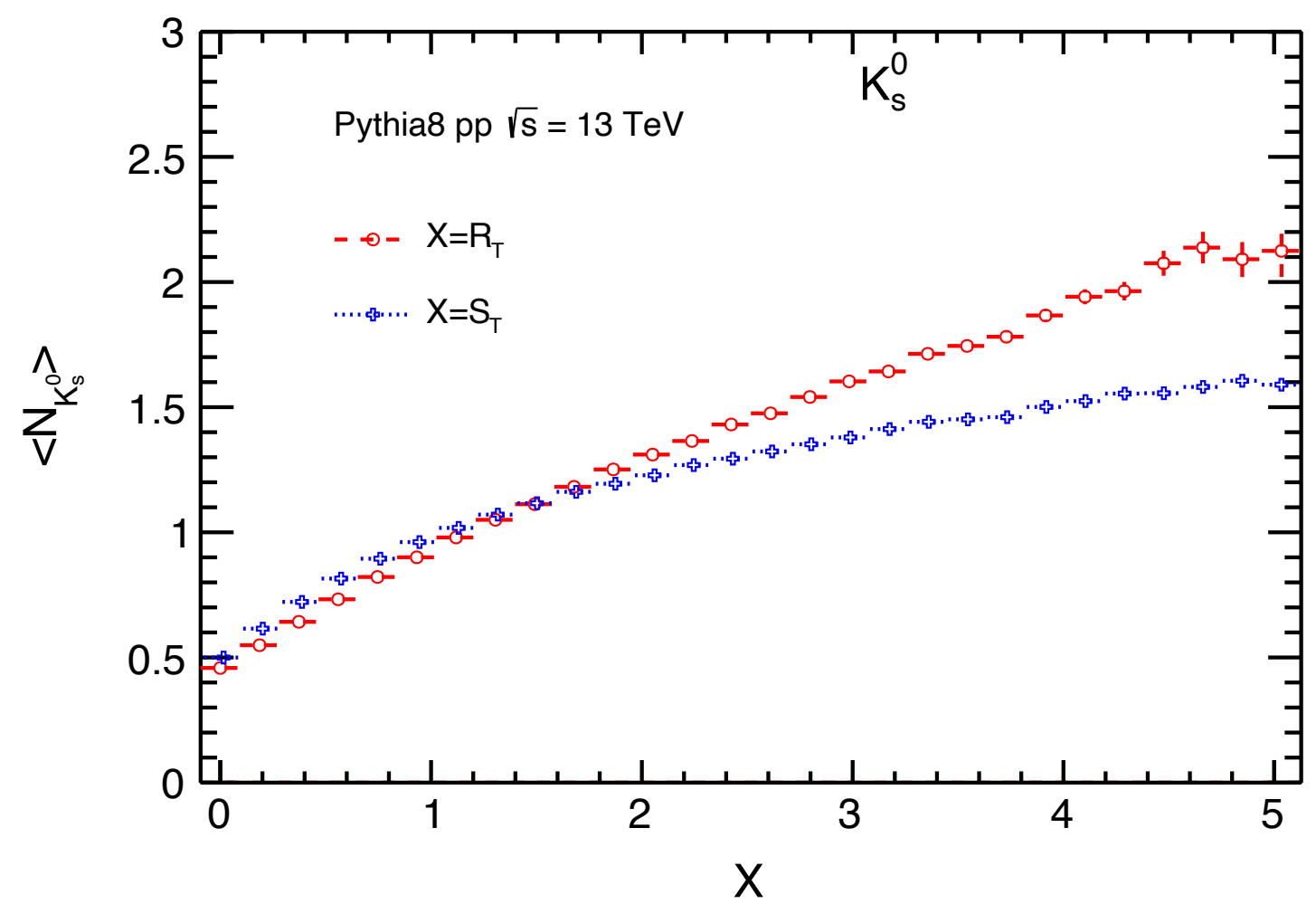
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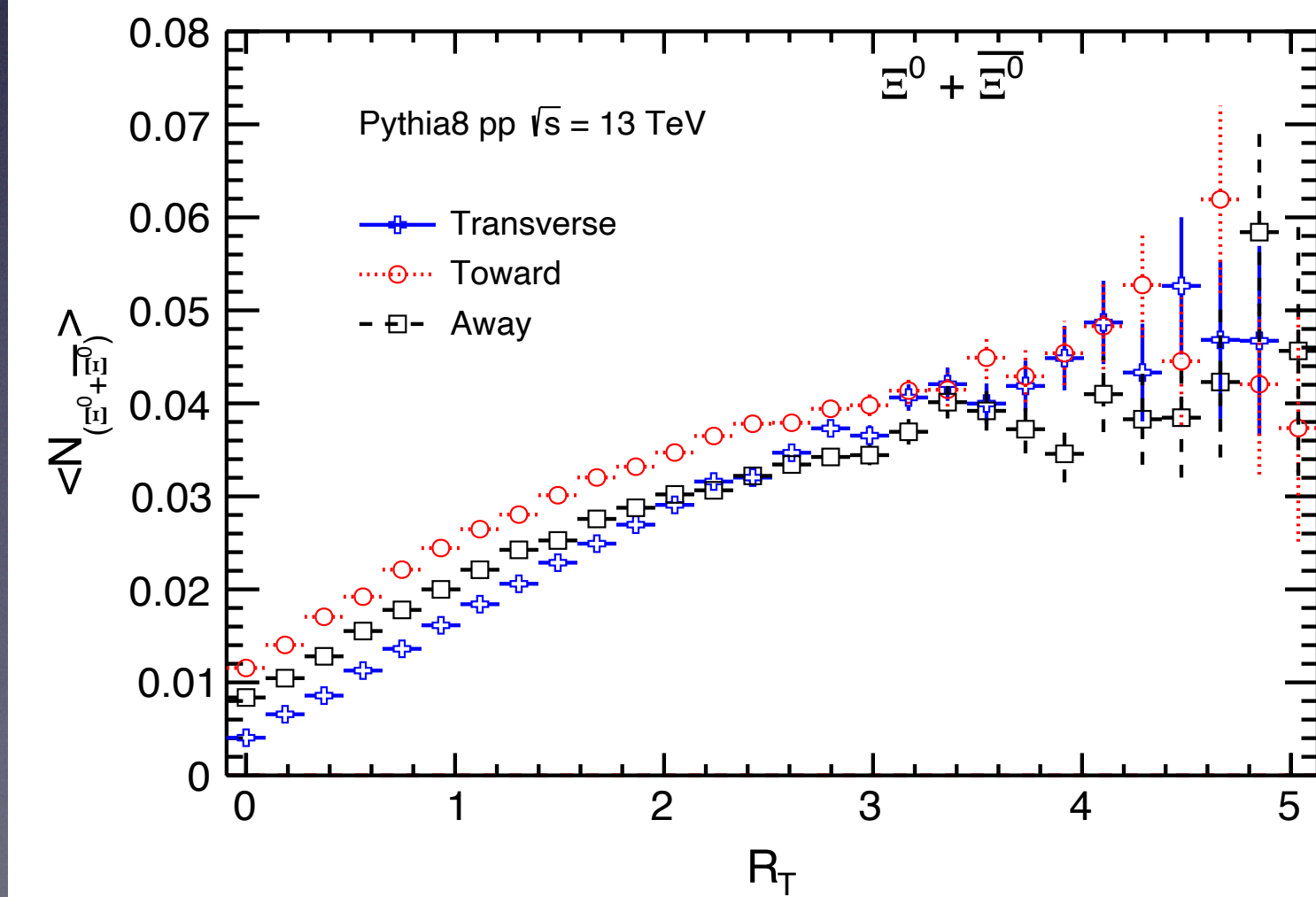
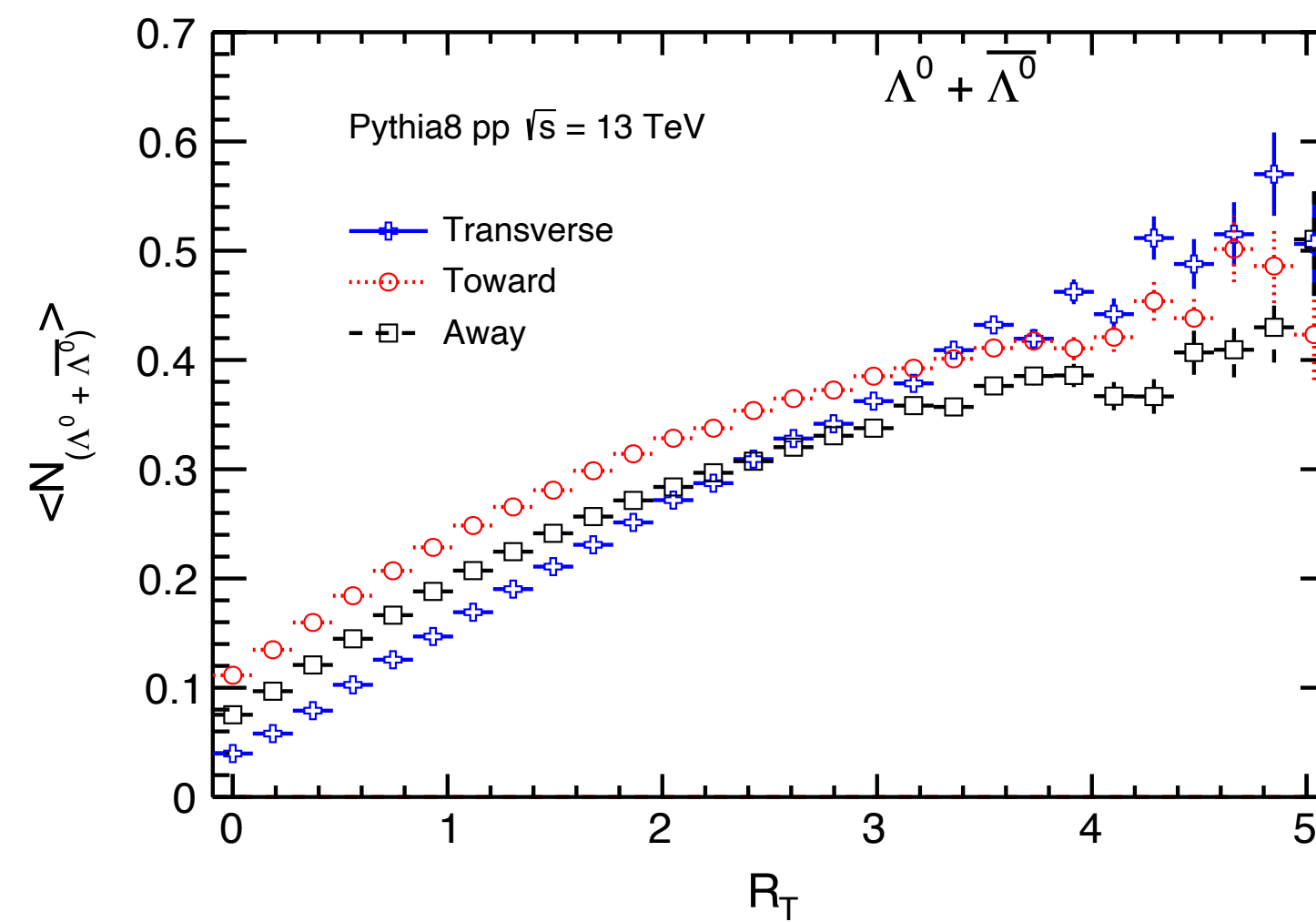
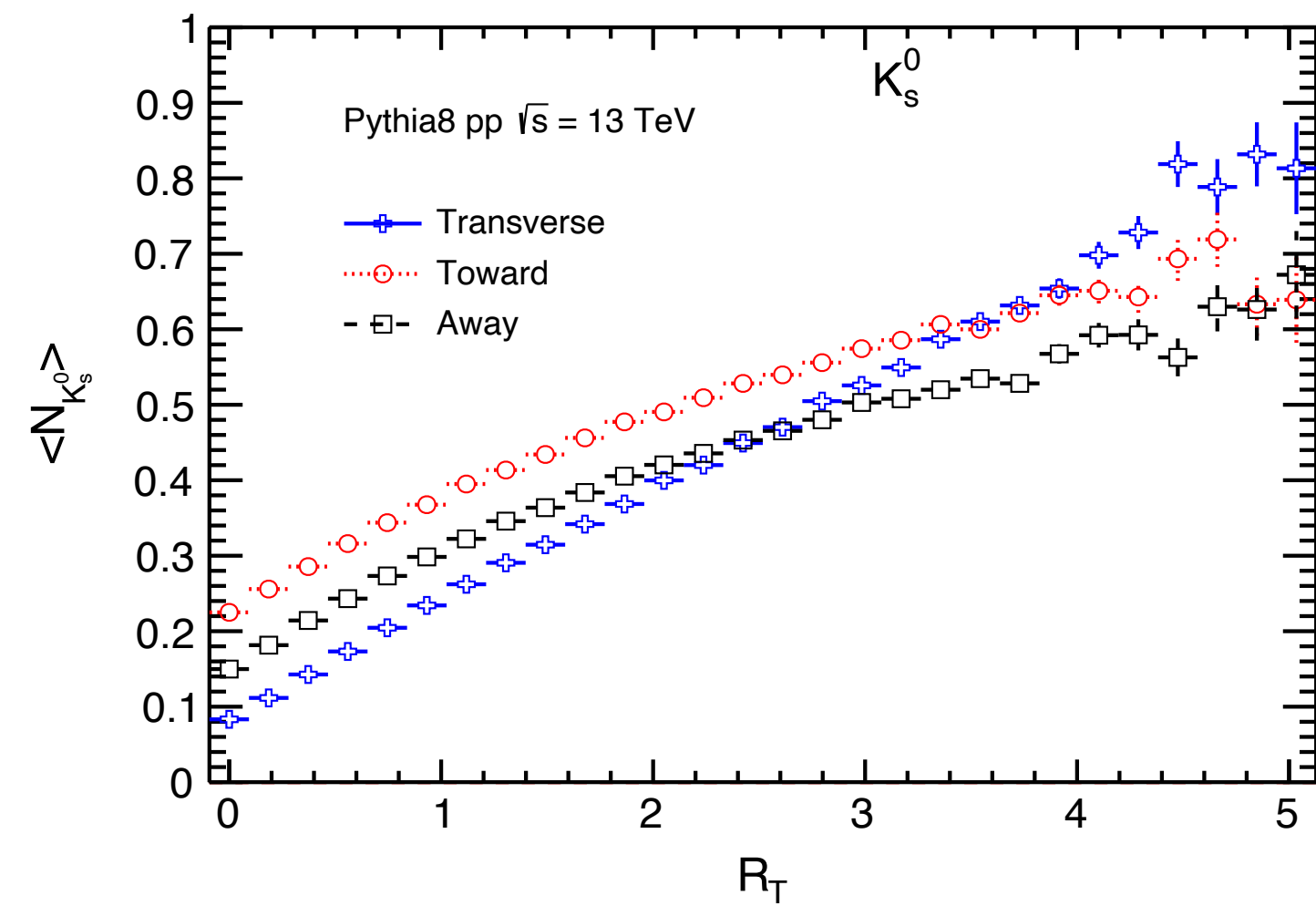
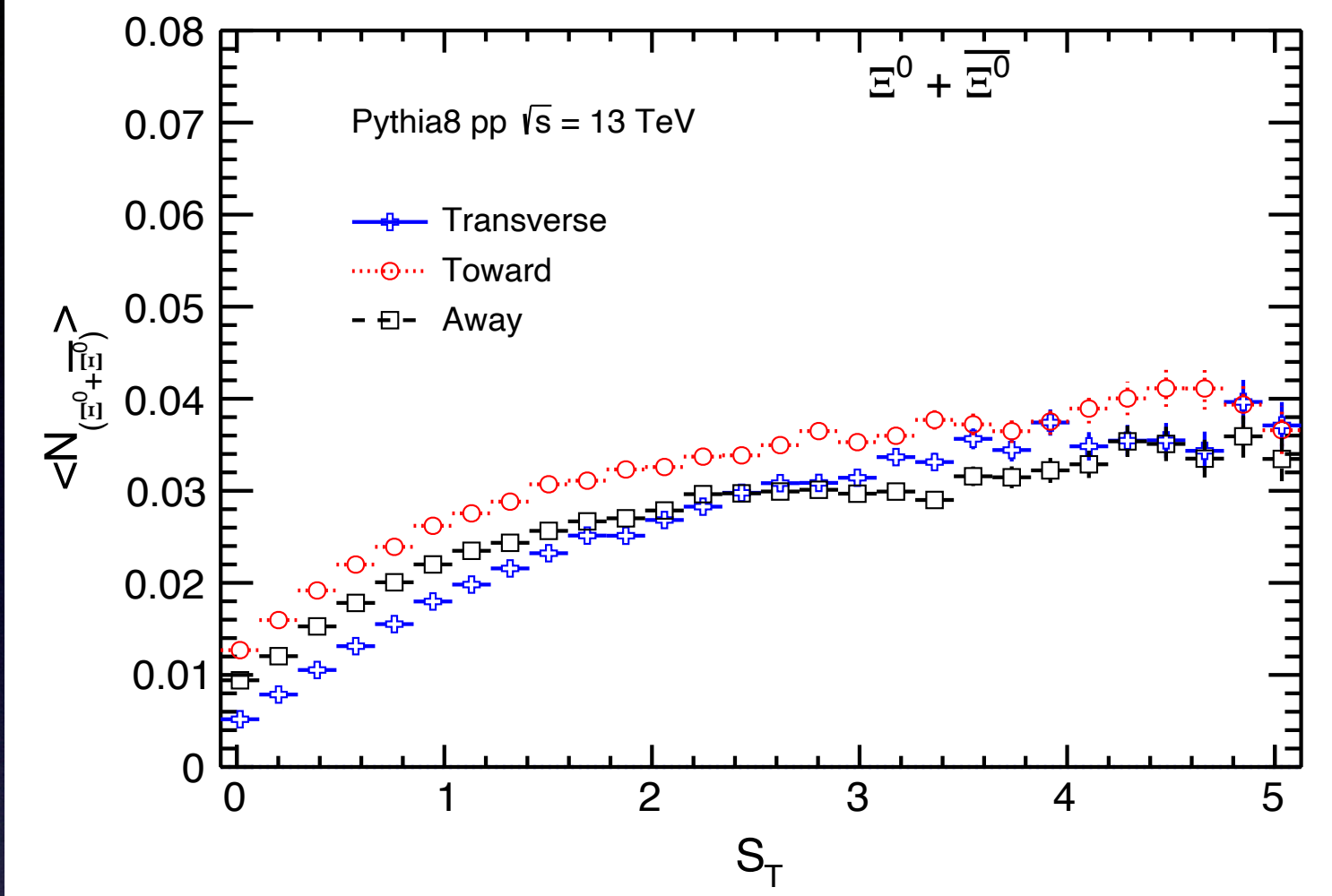
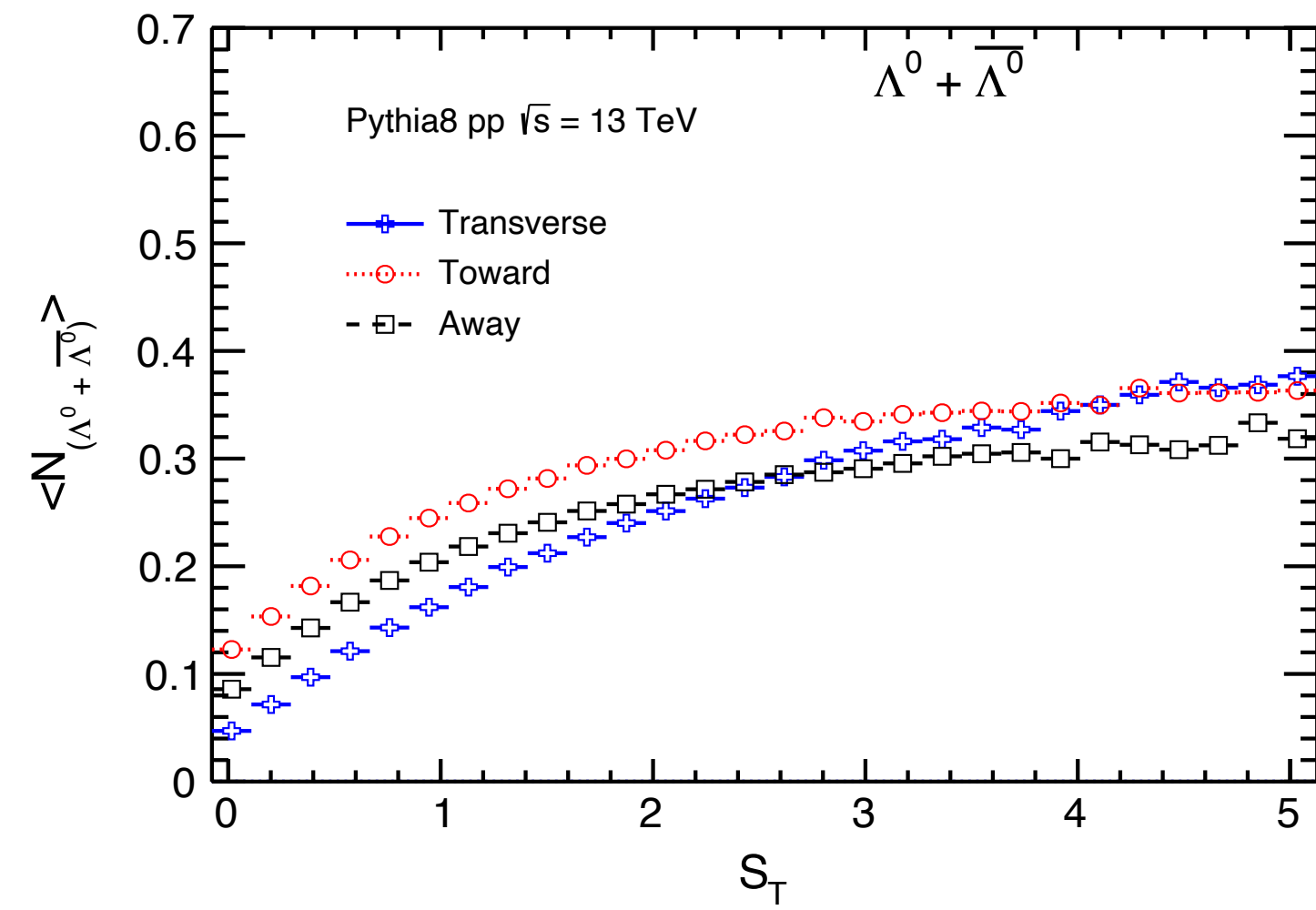
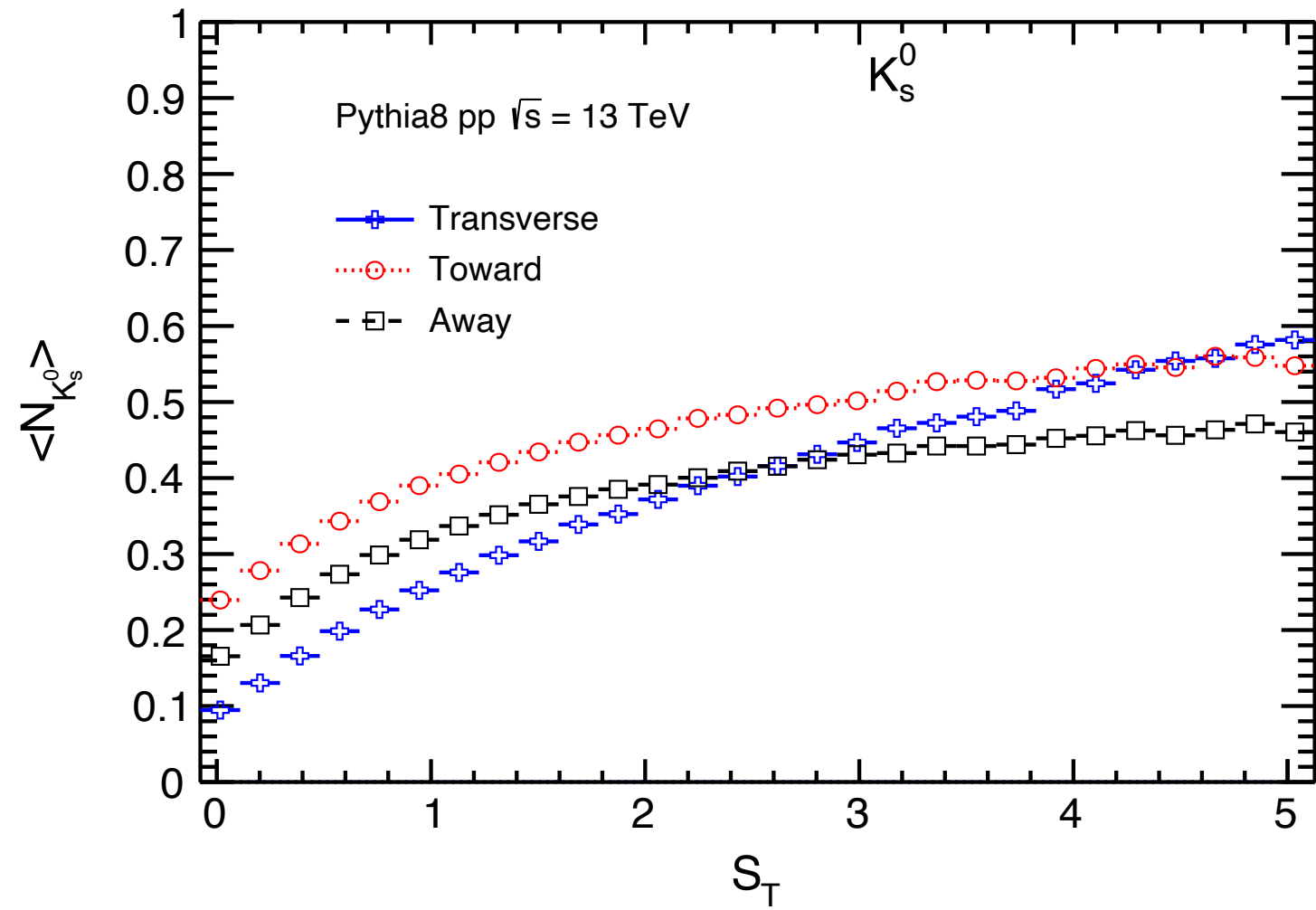
Identified Particles : Kshorts Lambdas, Cascades (Xis)



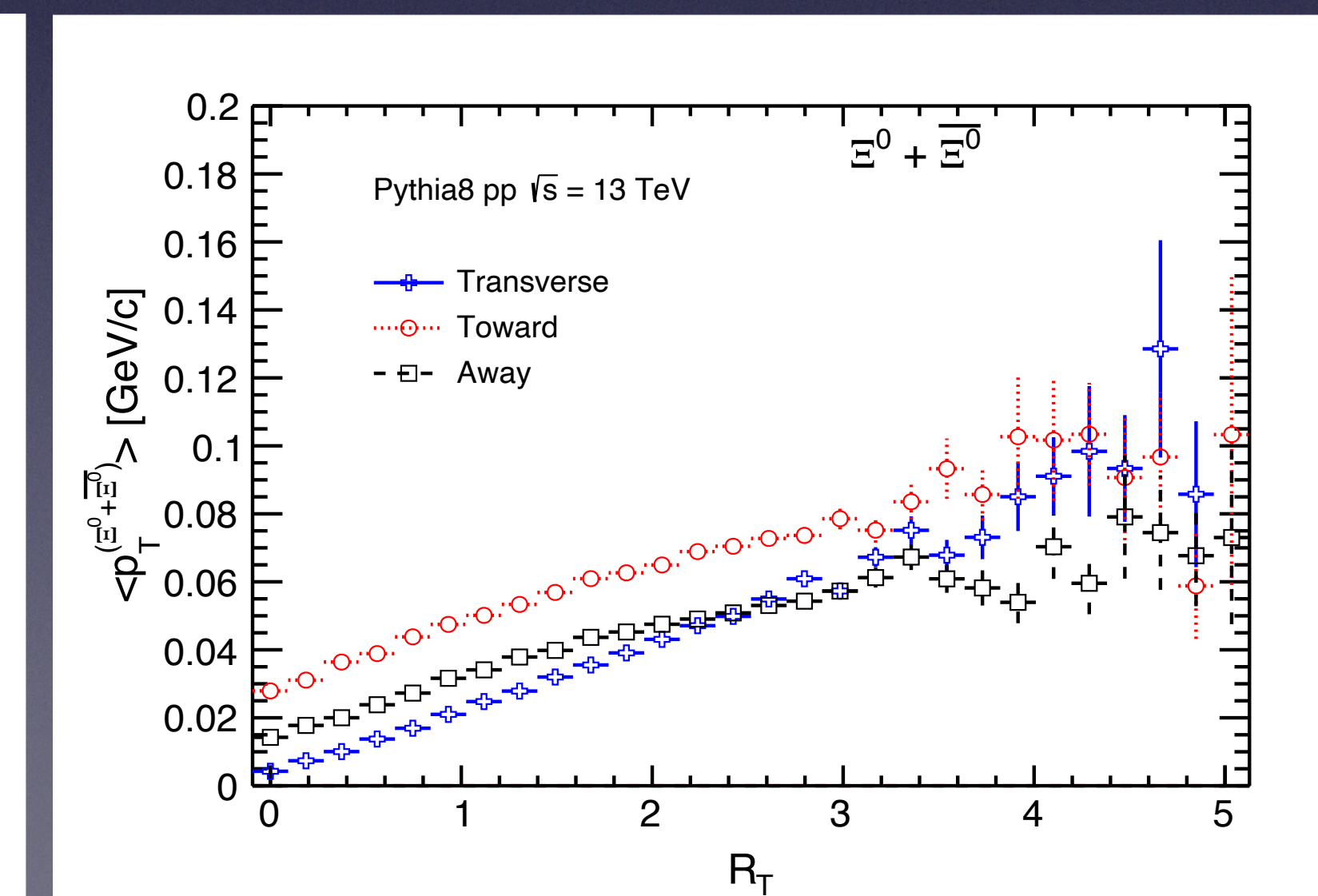
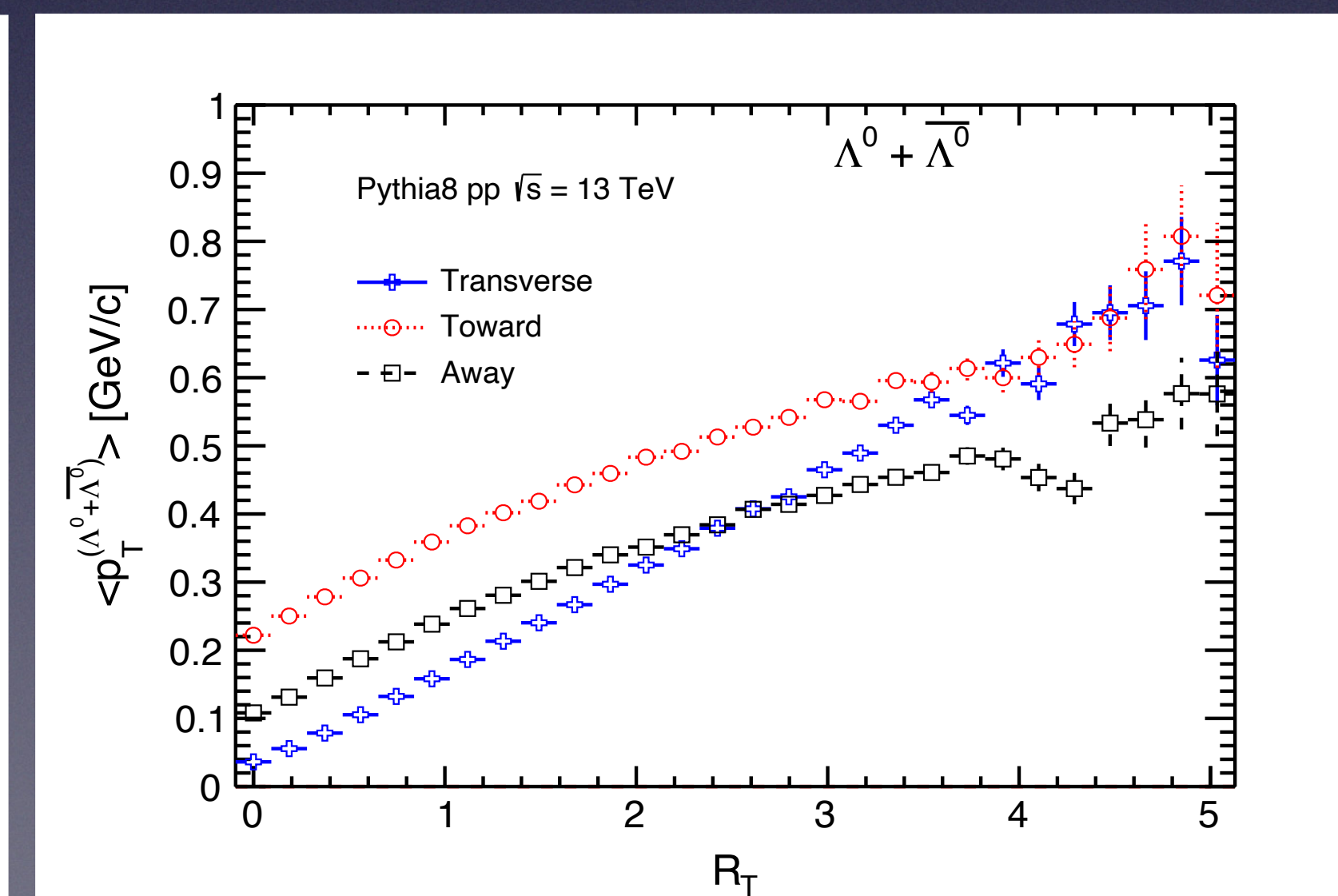
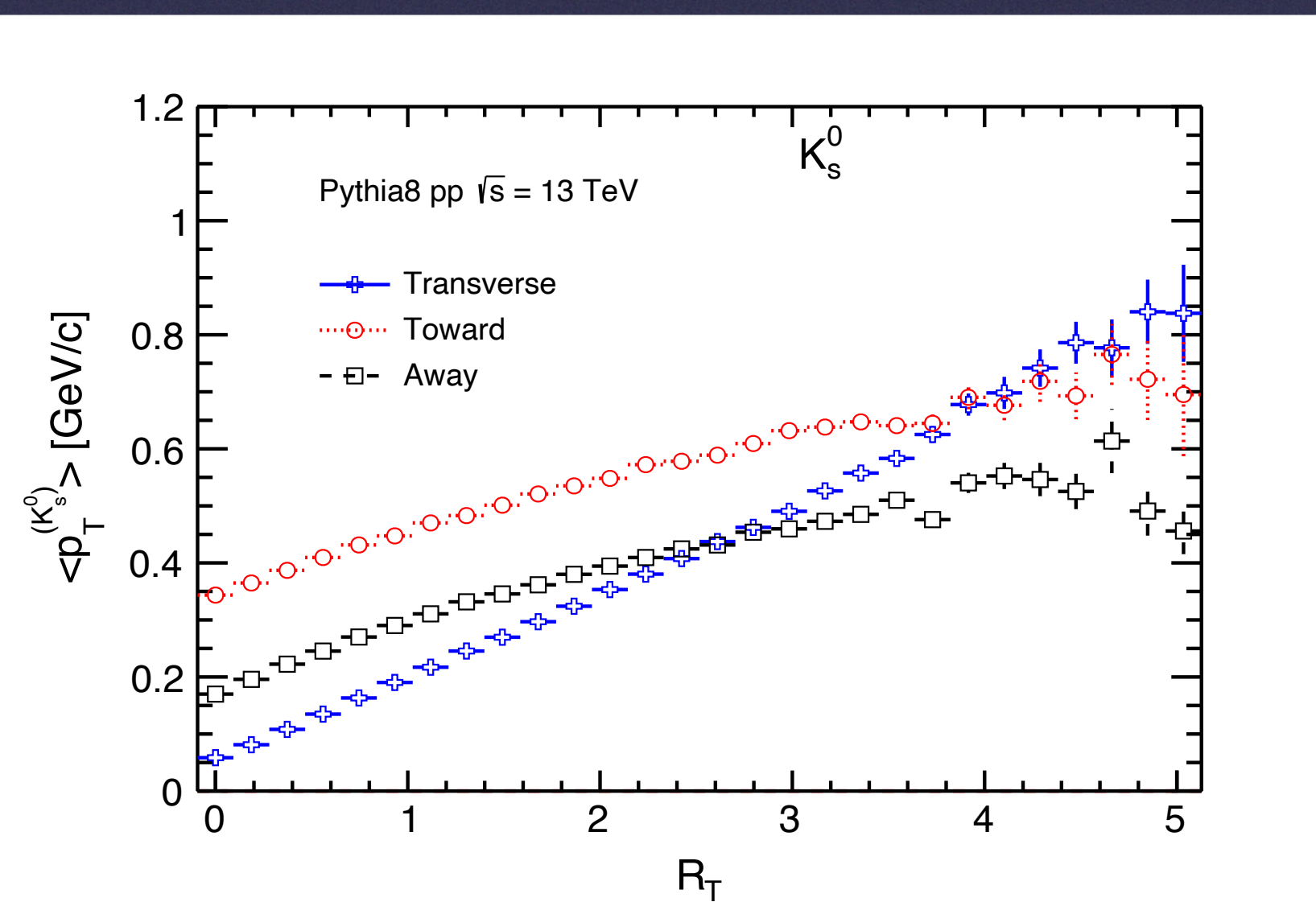
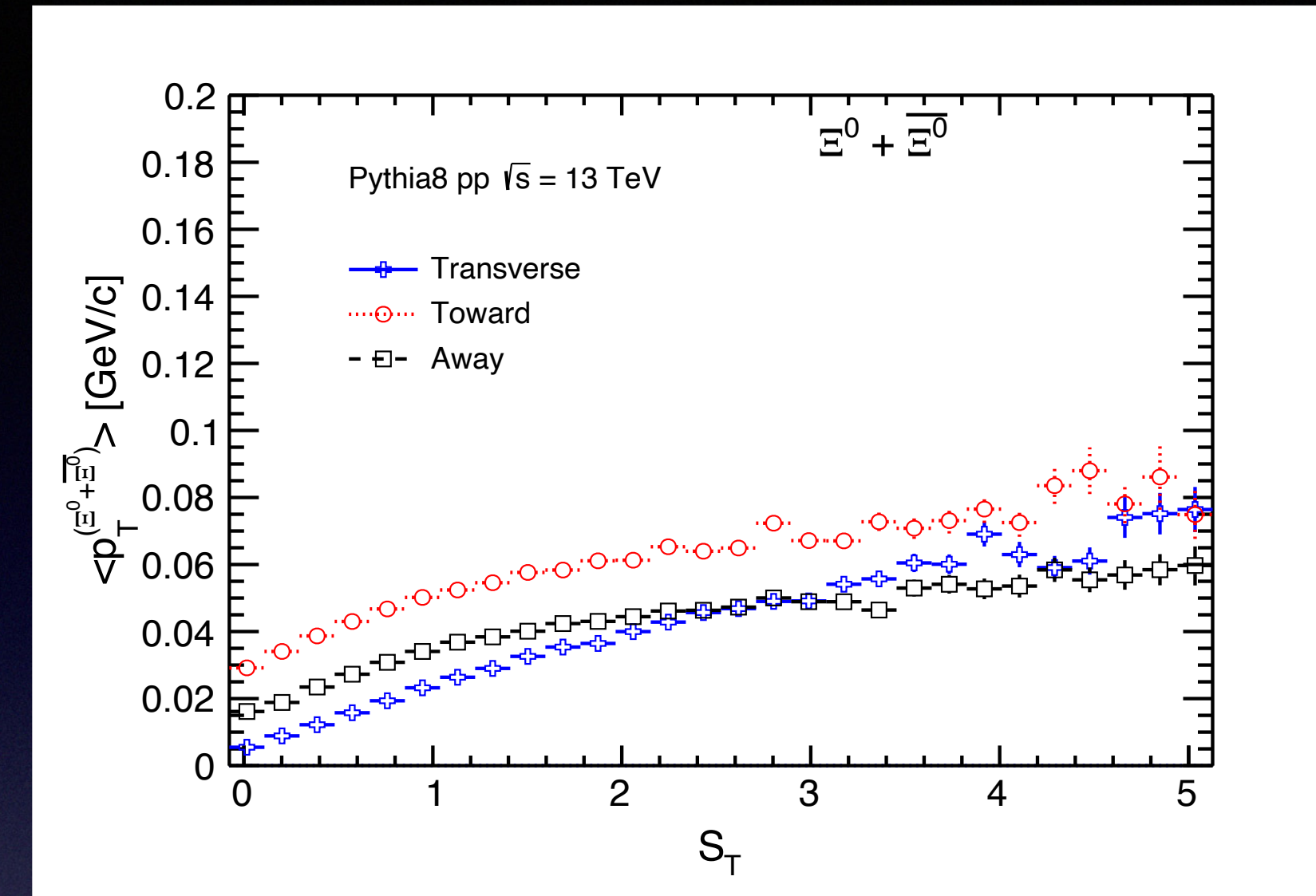
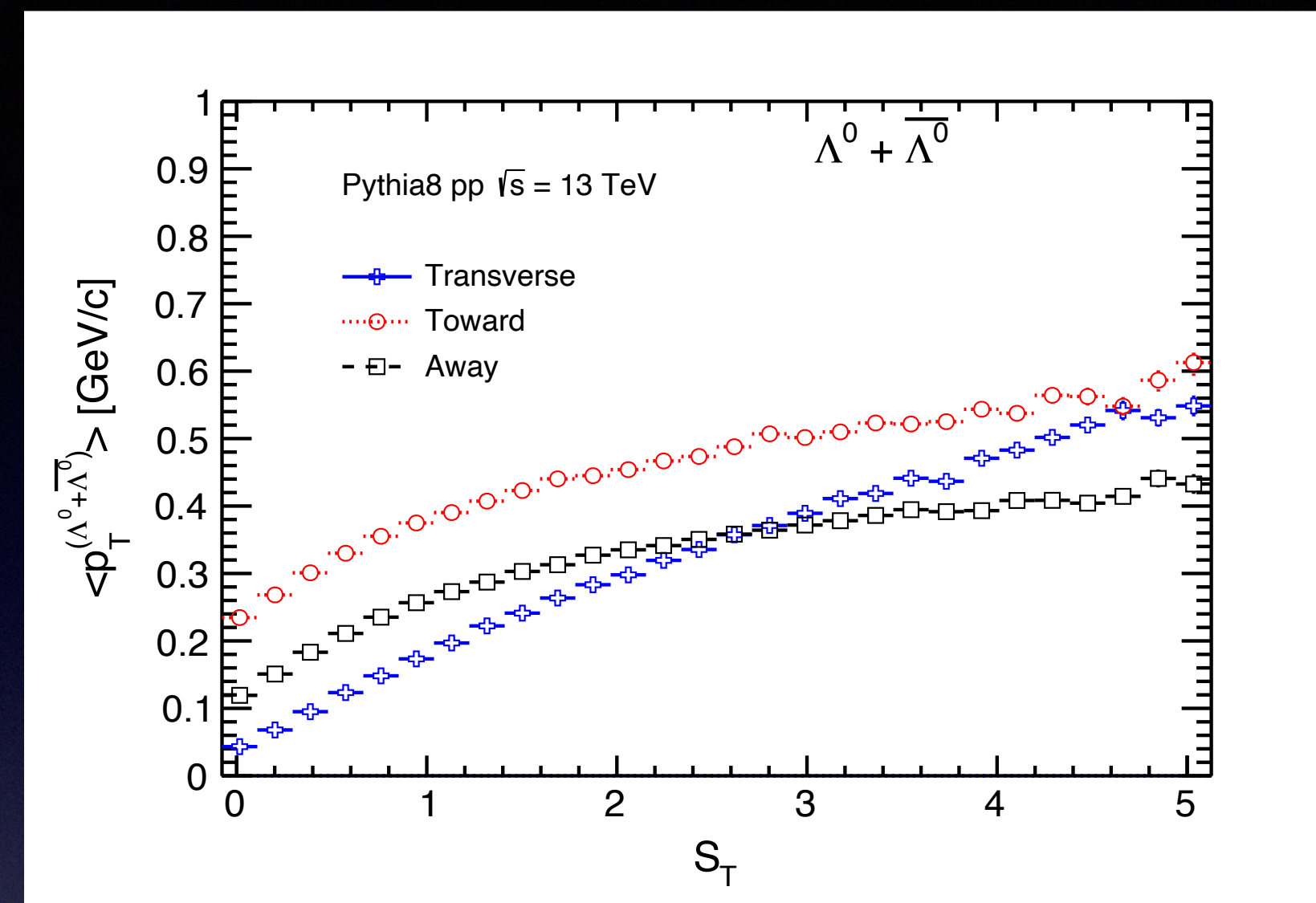
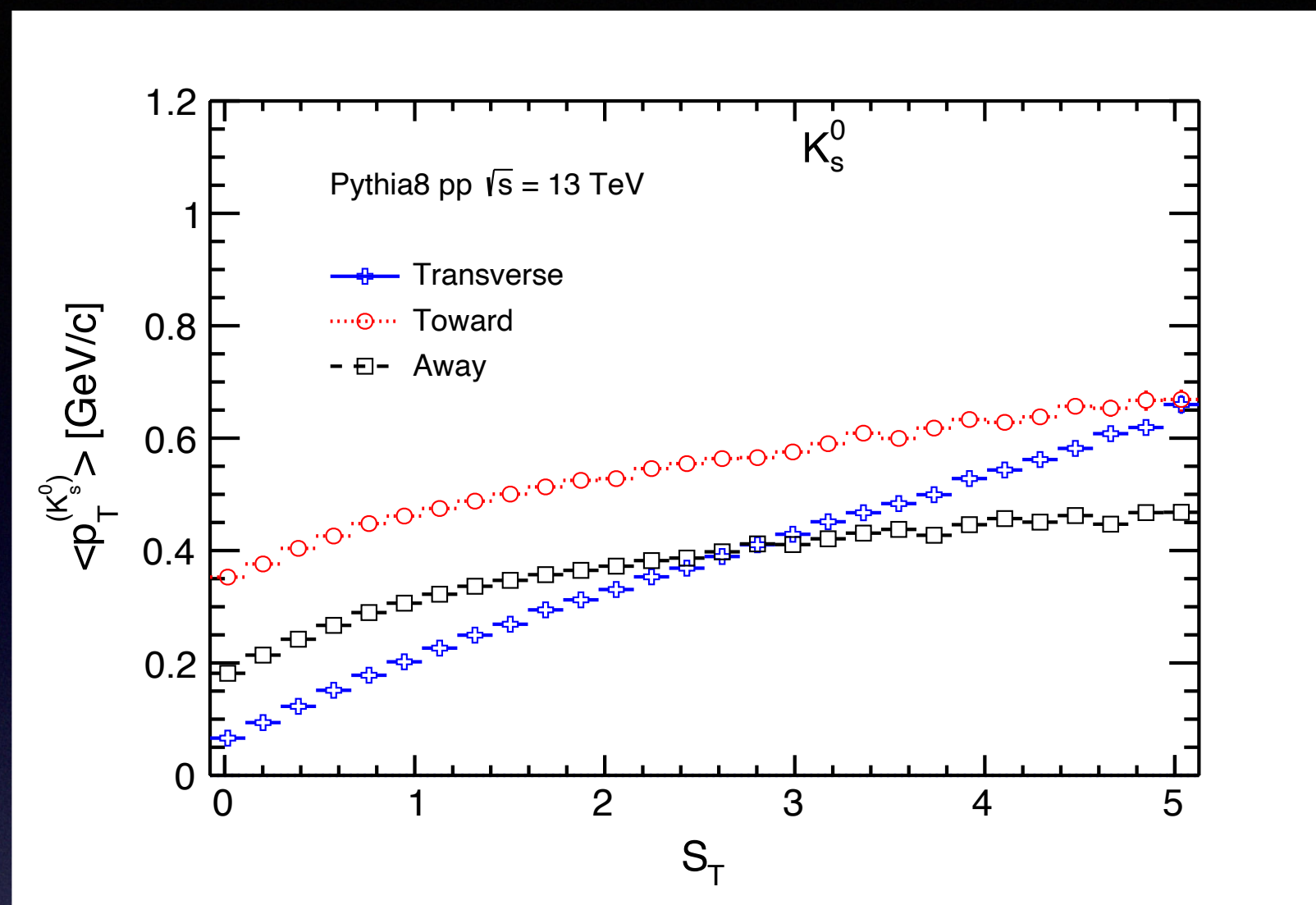
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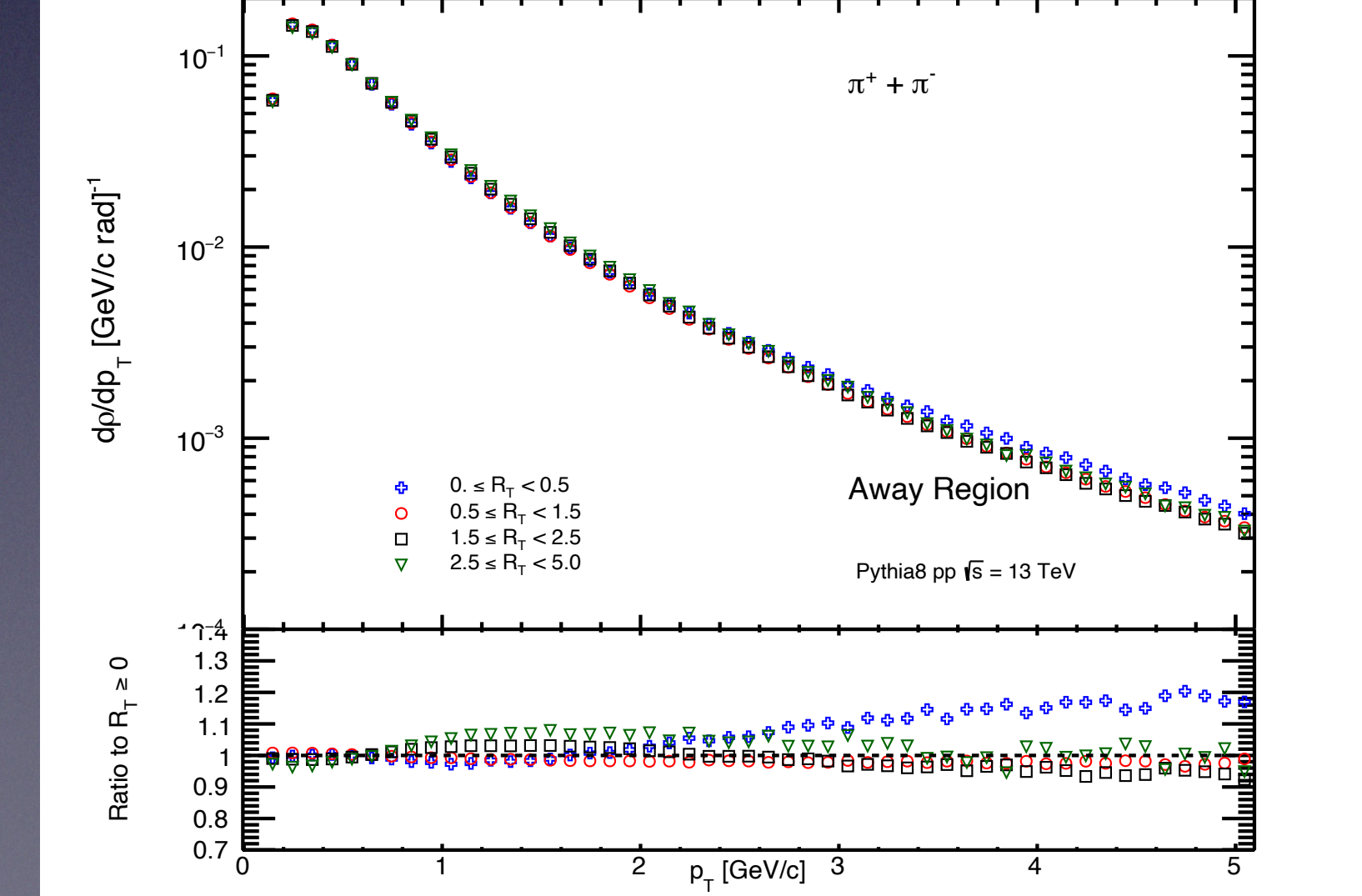
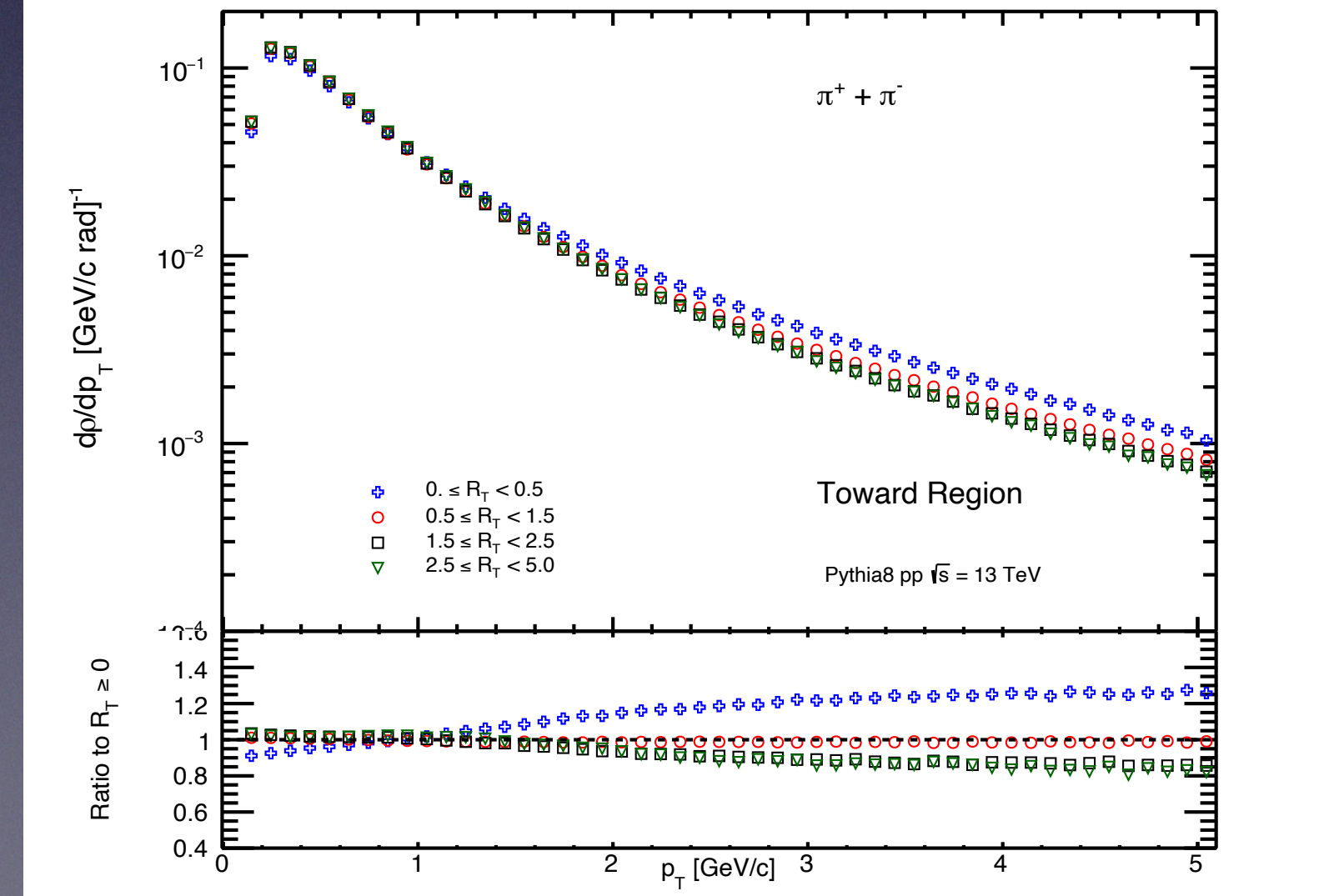
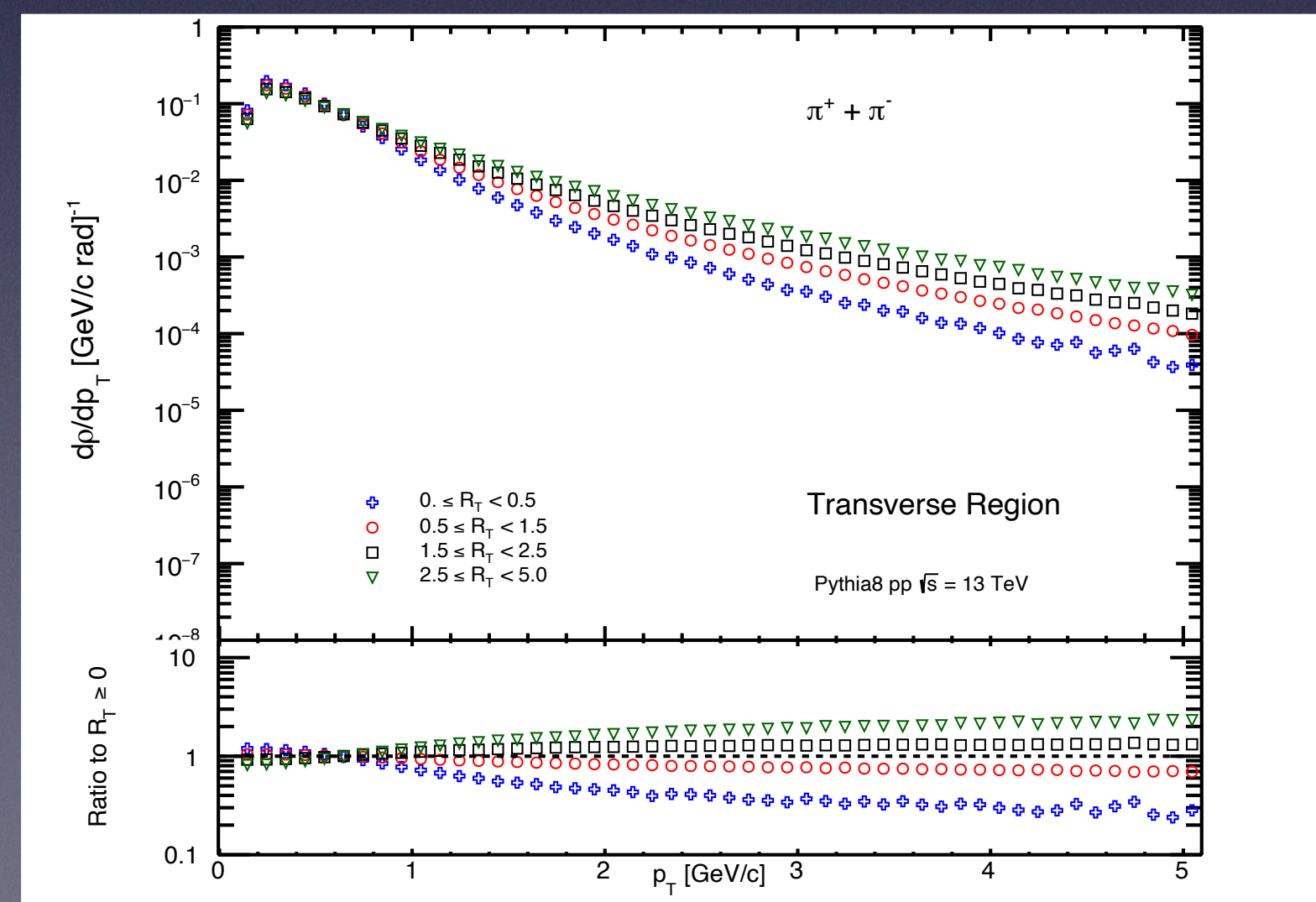
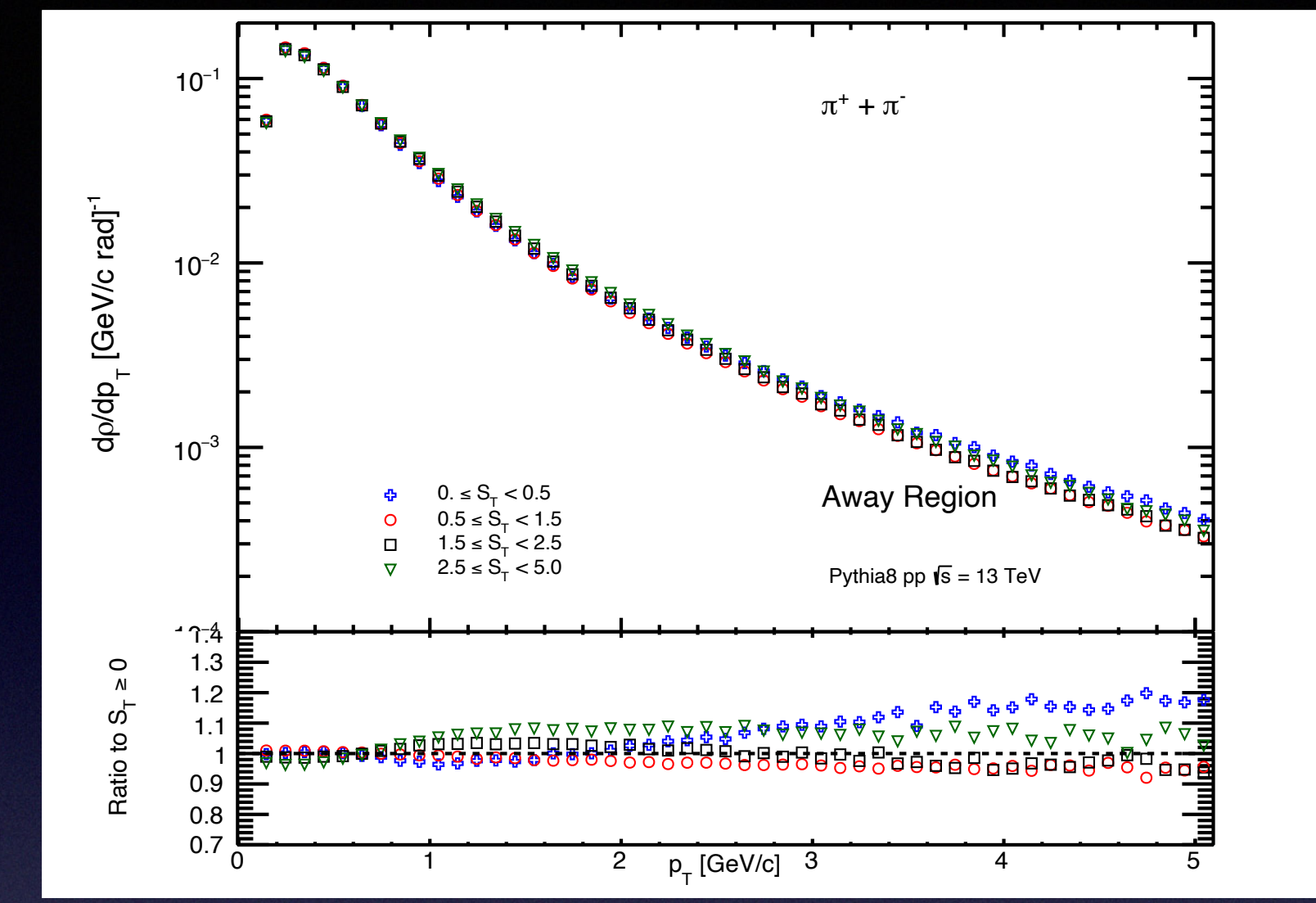
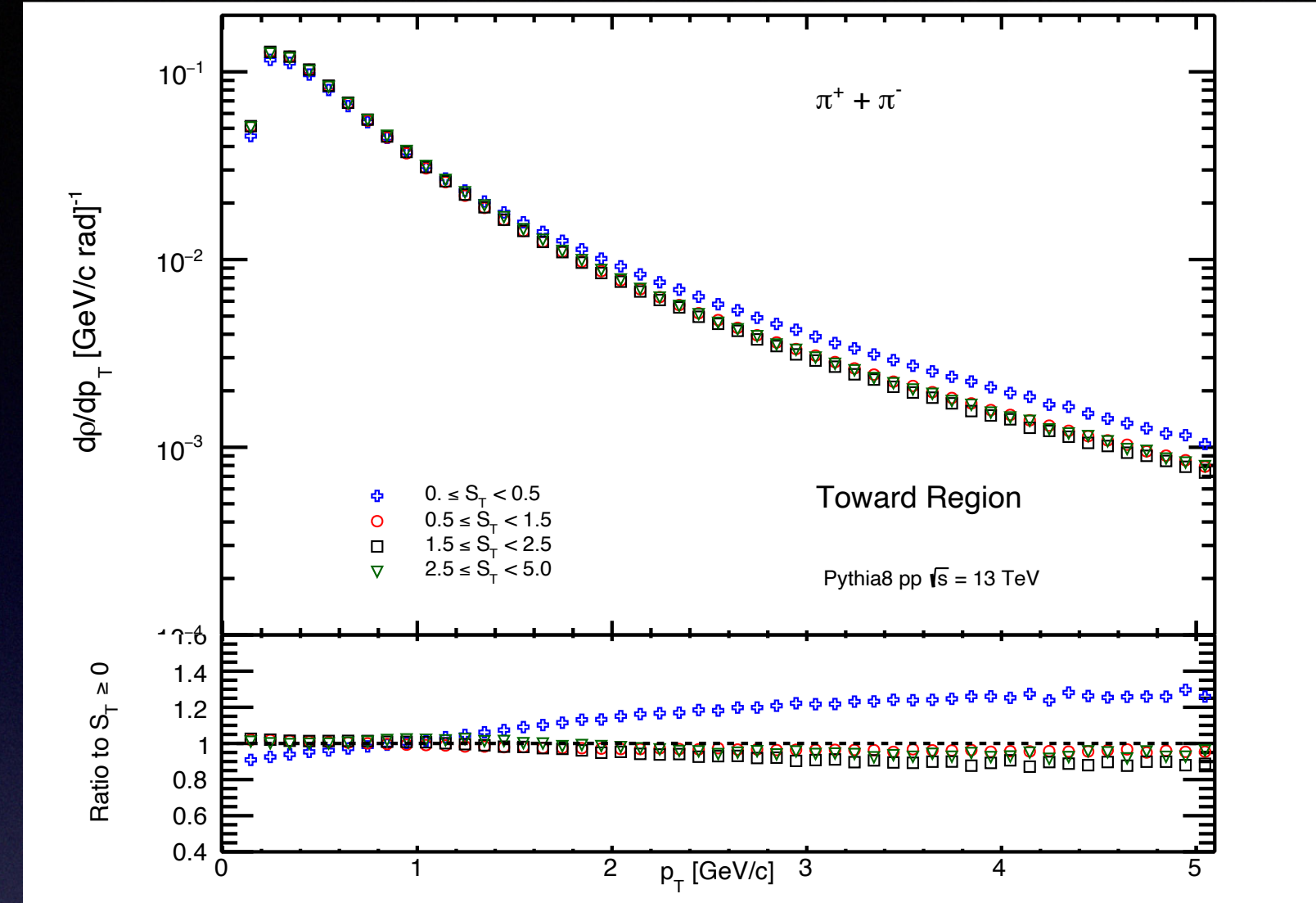
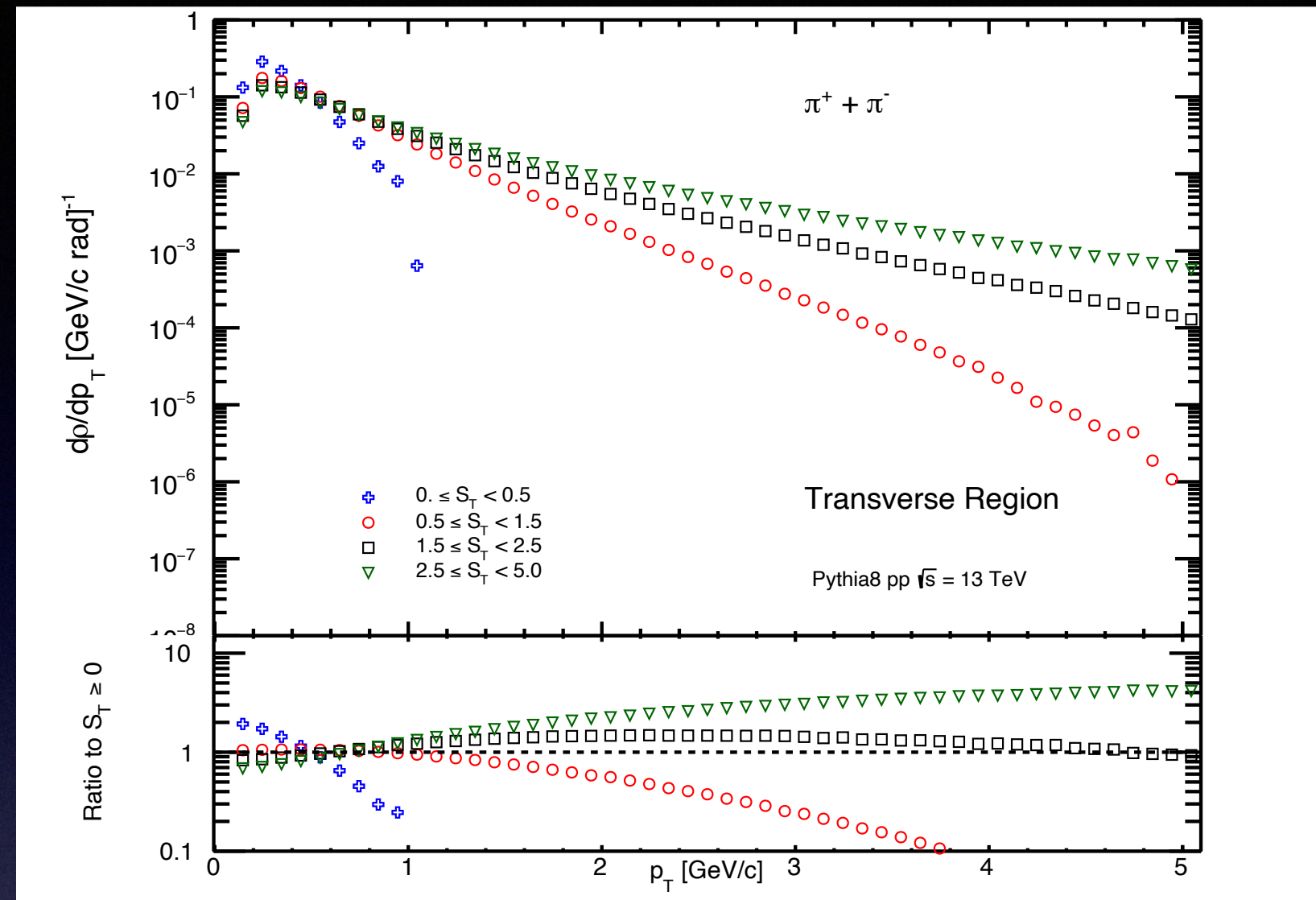
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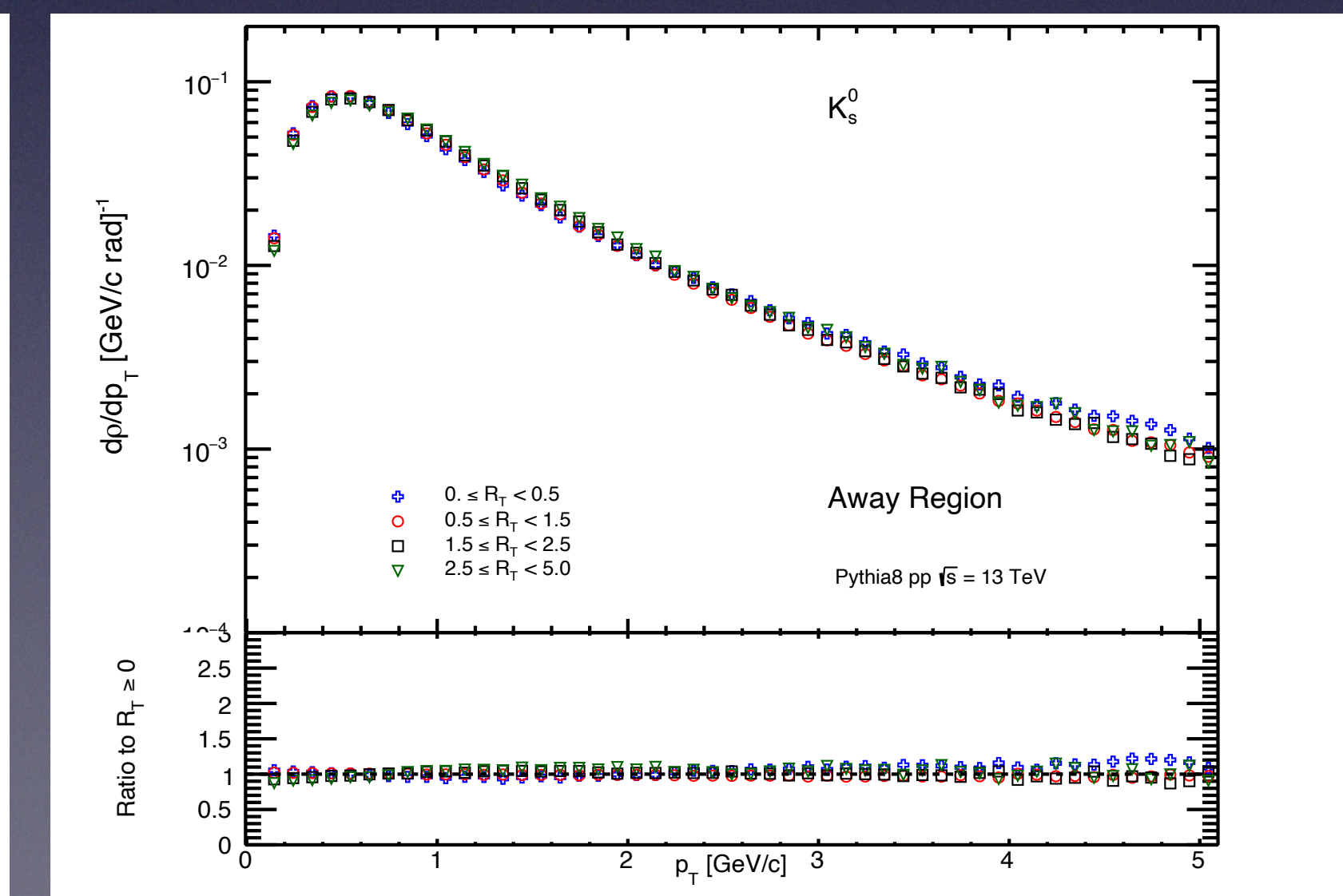
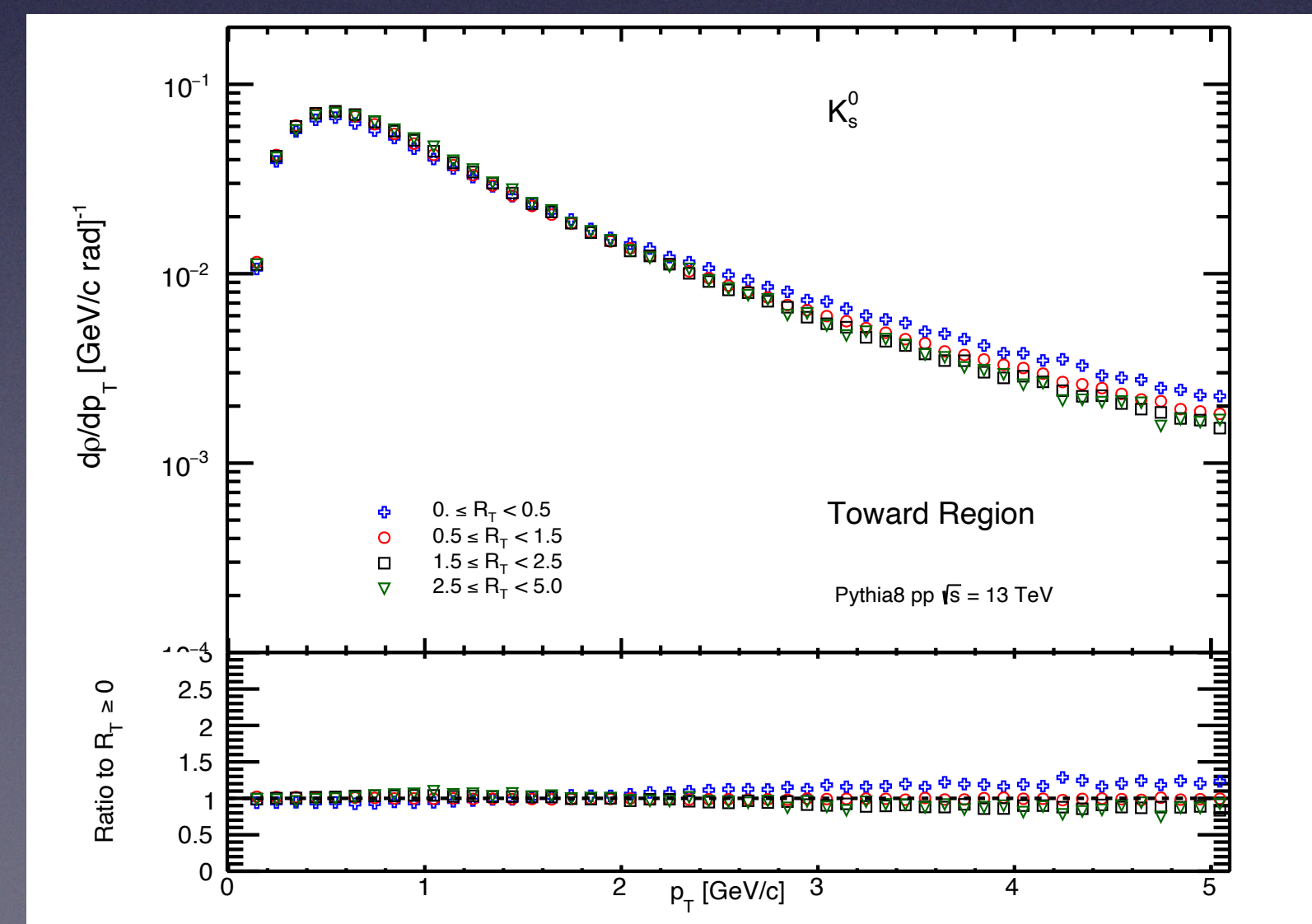
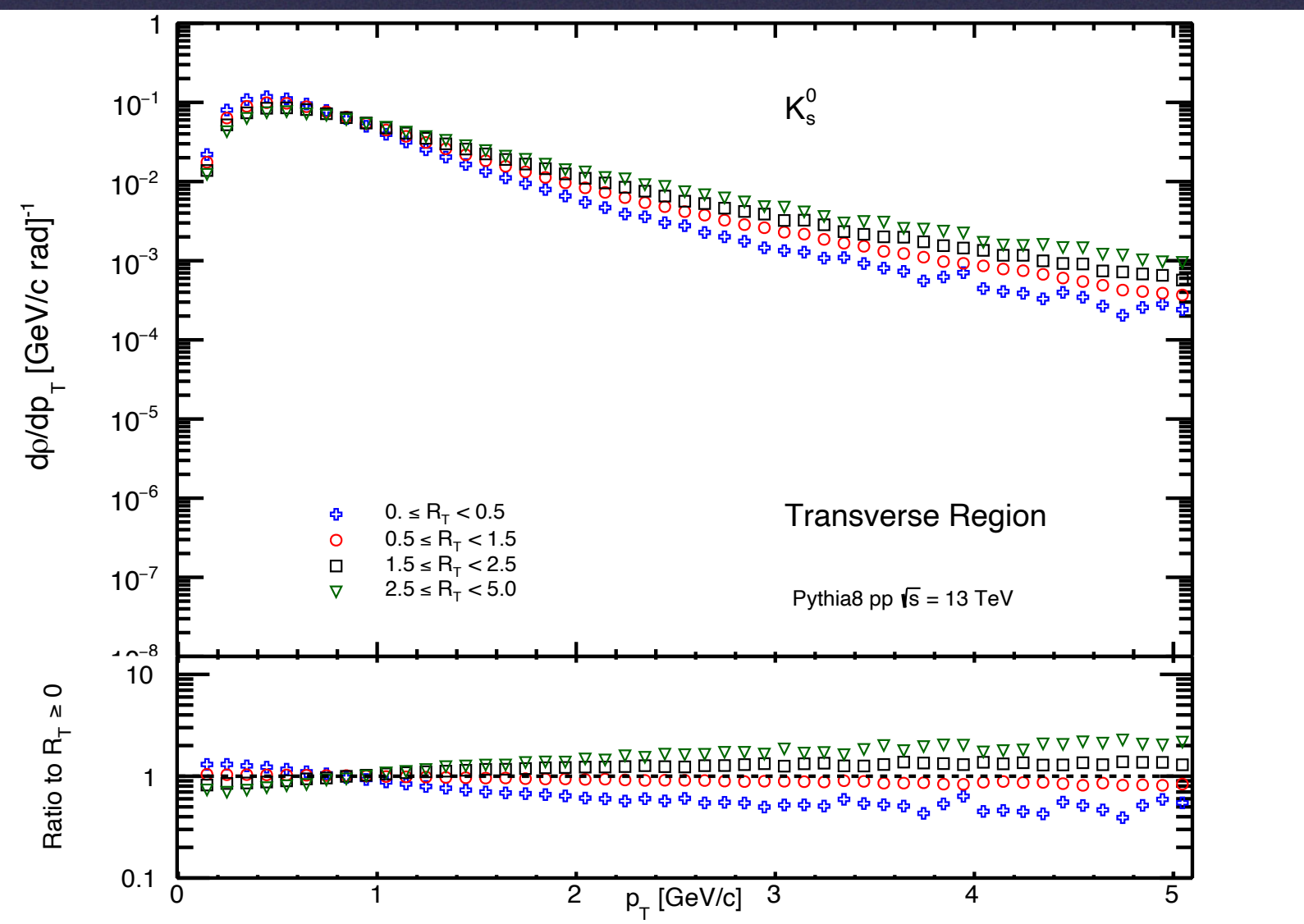
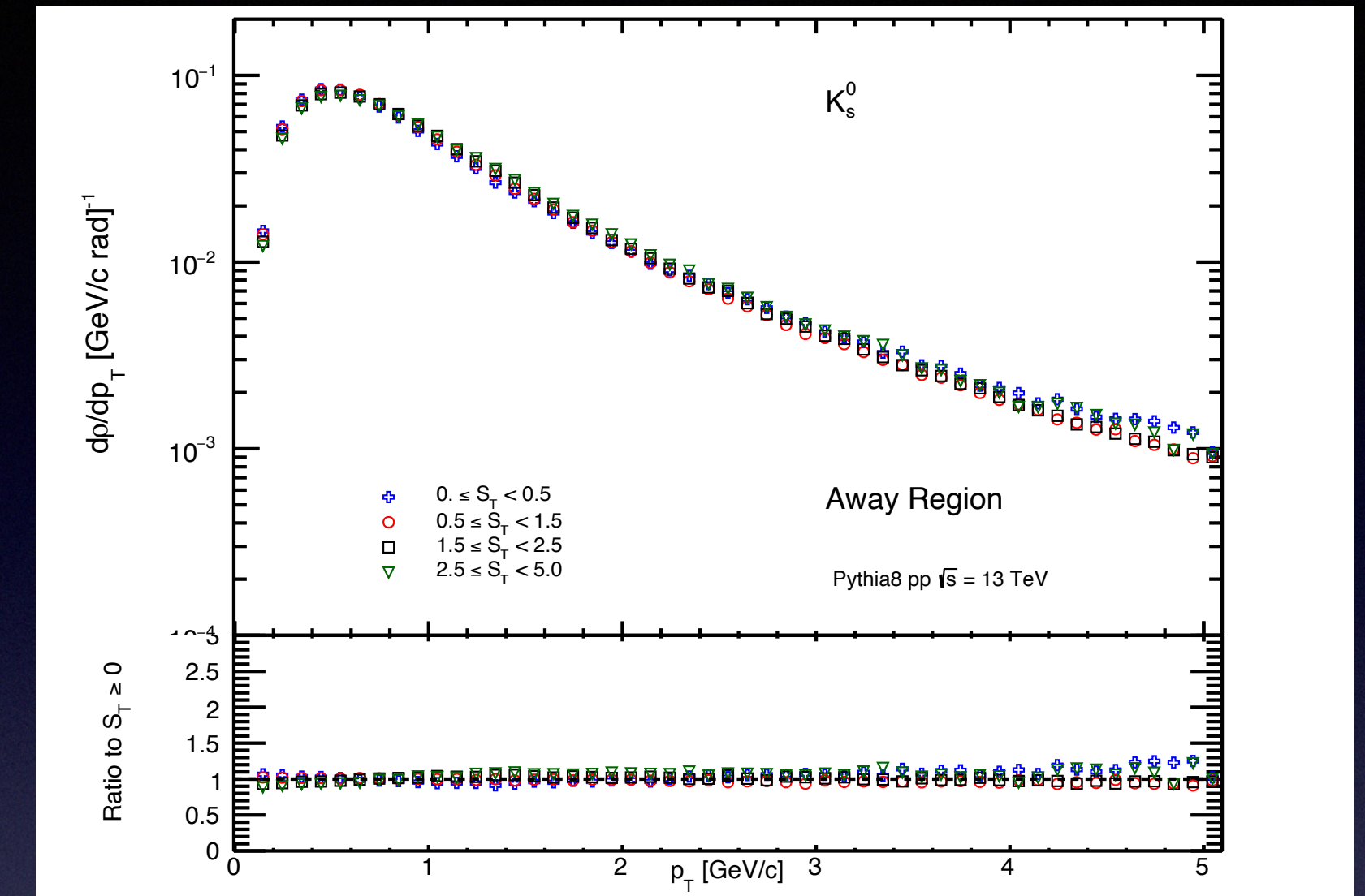
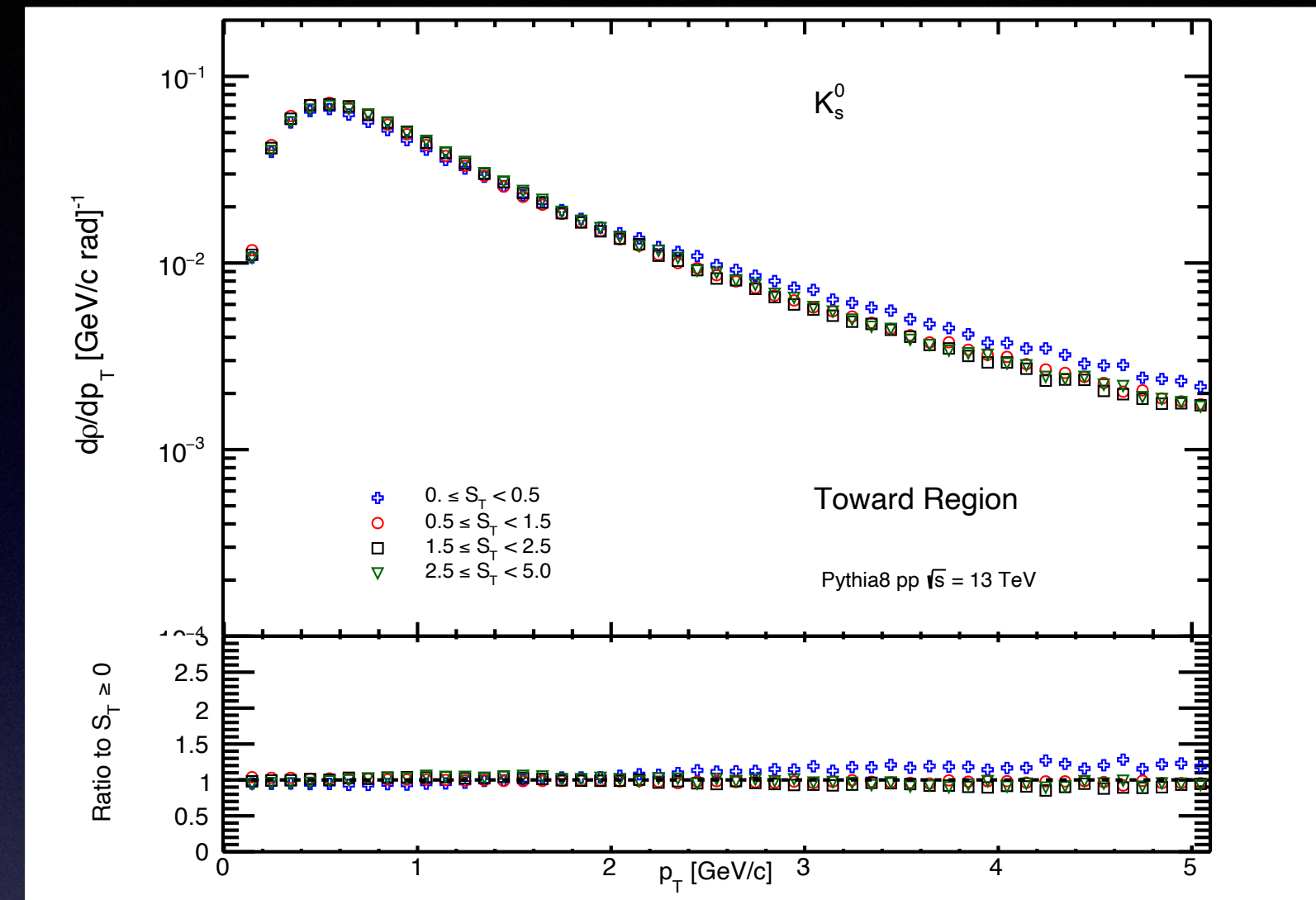
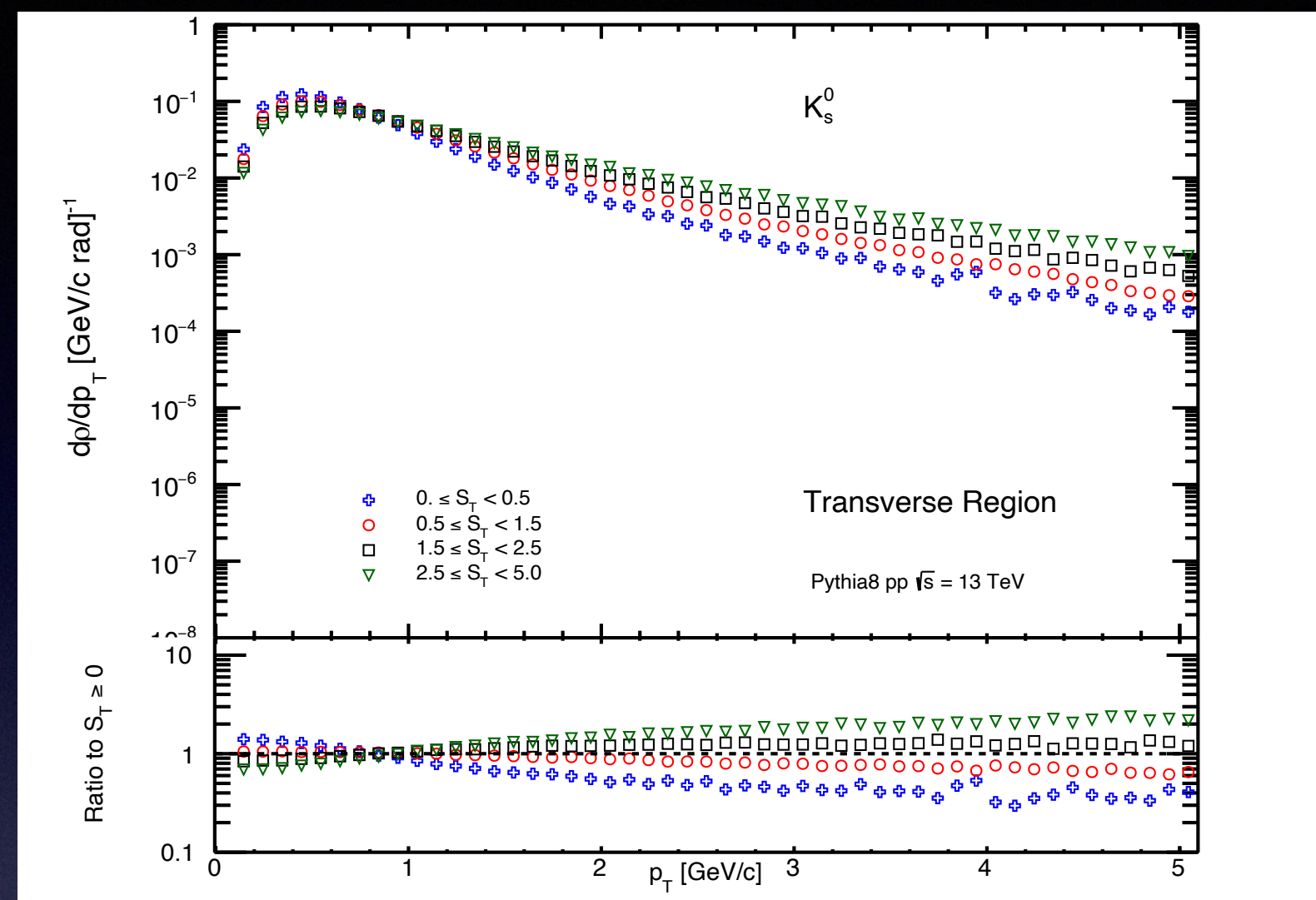
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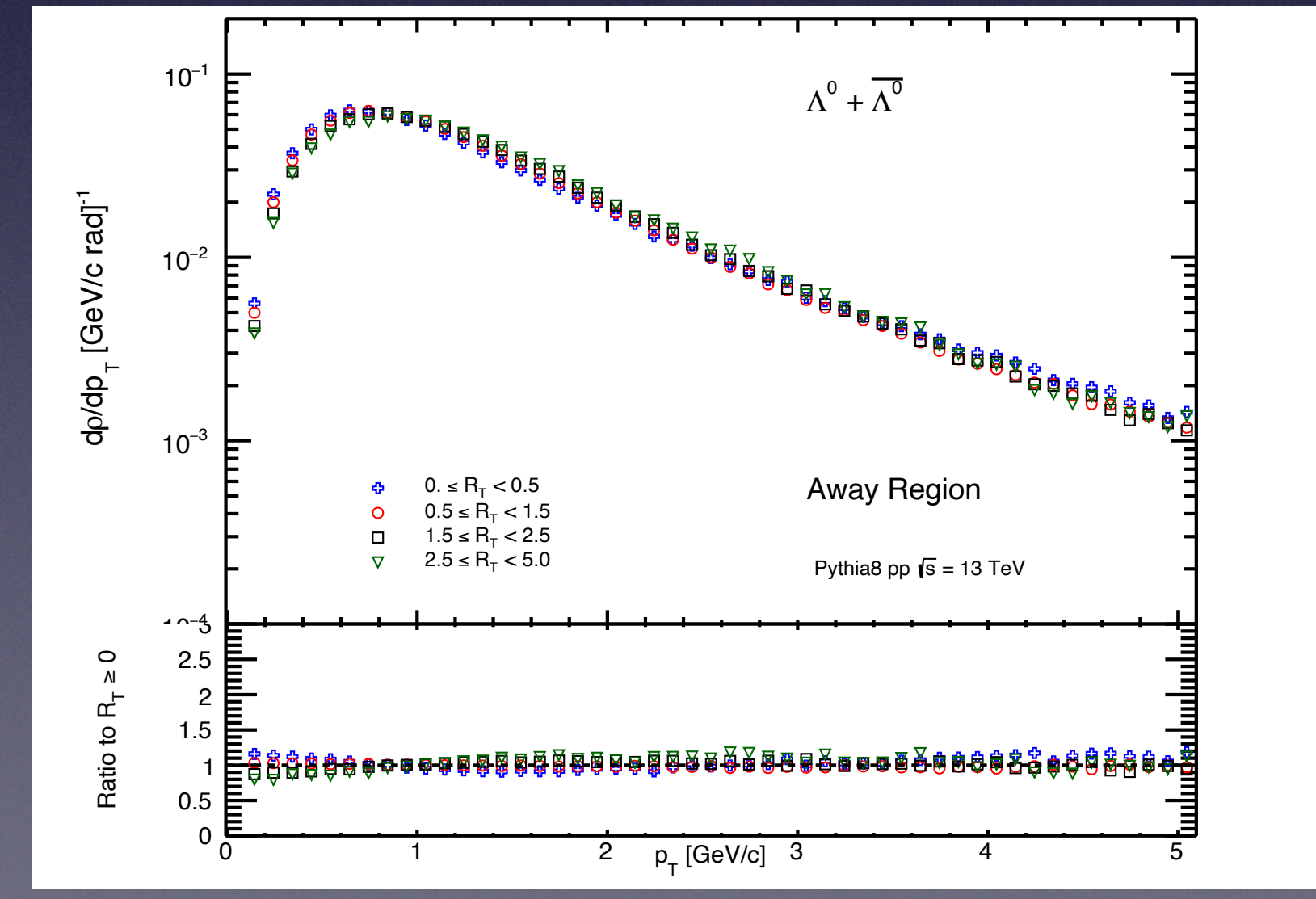
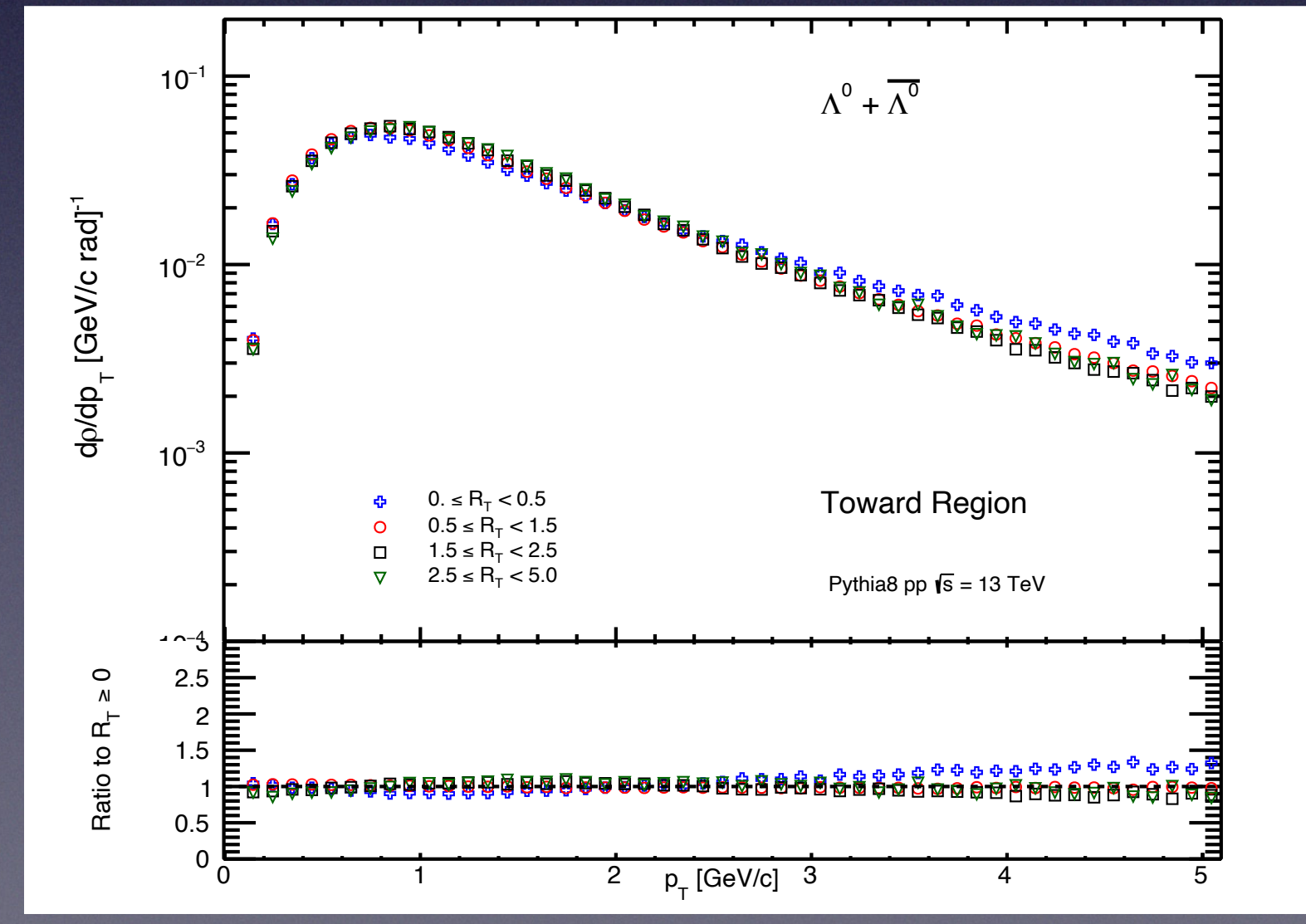
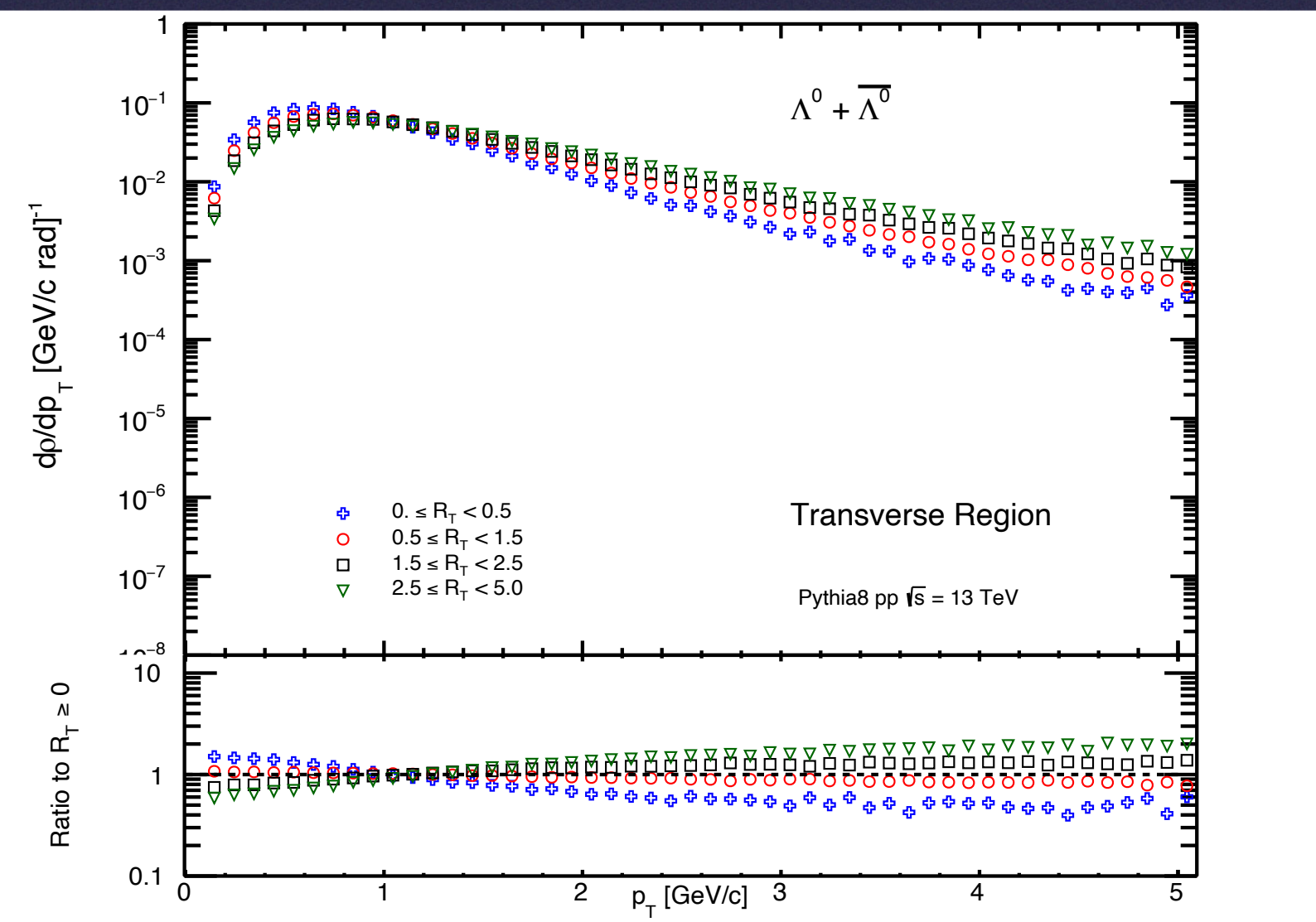
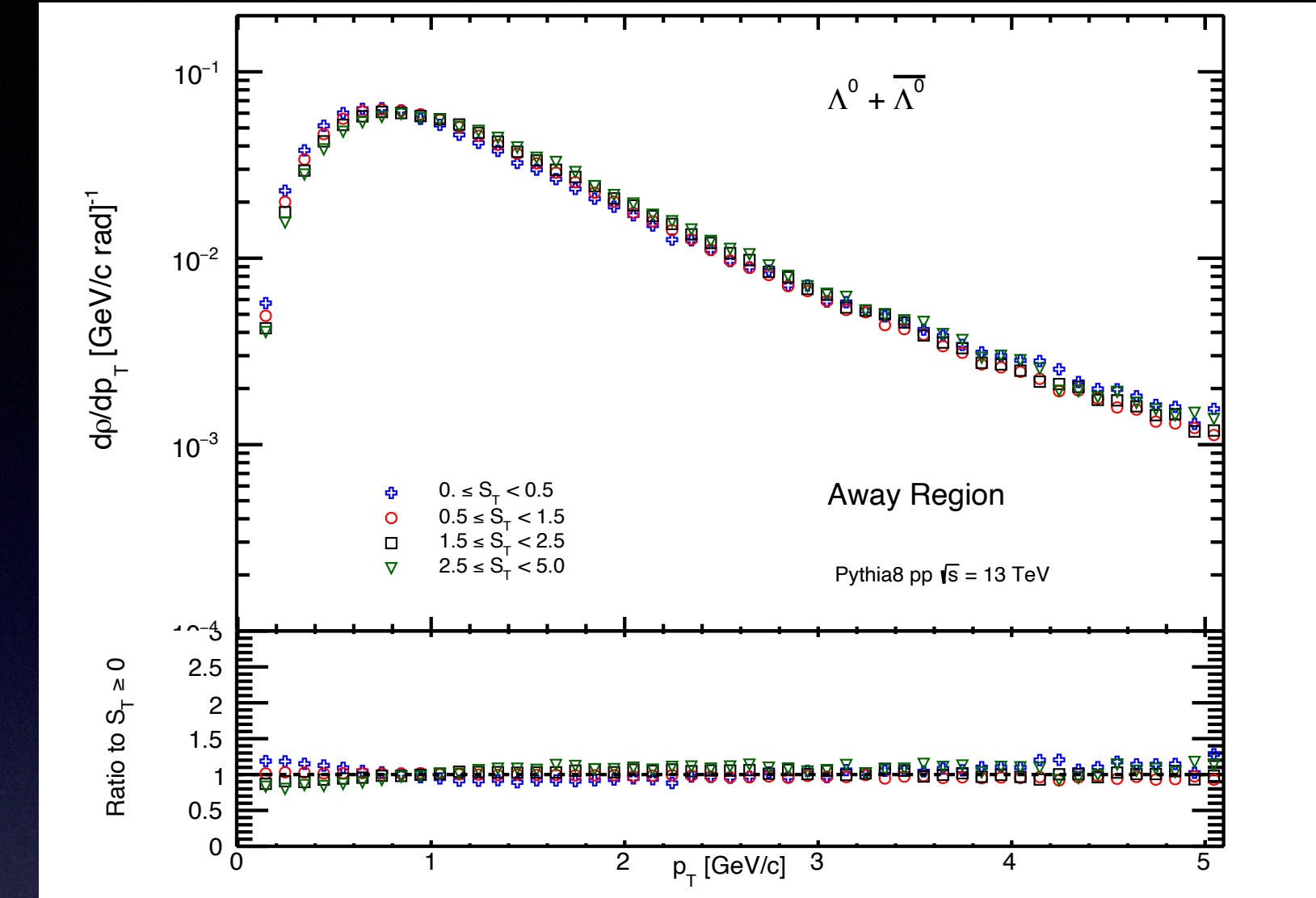
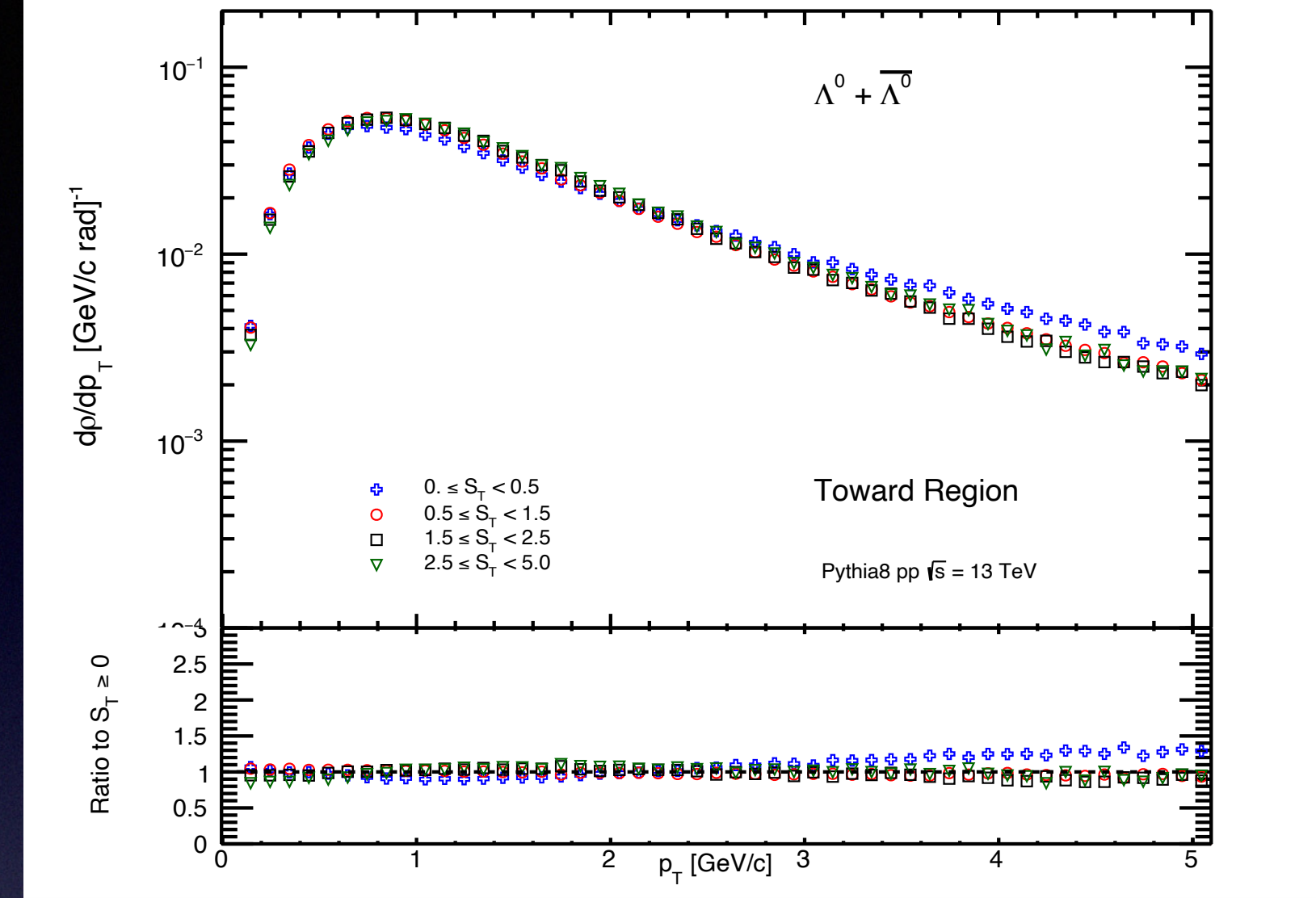
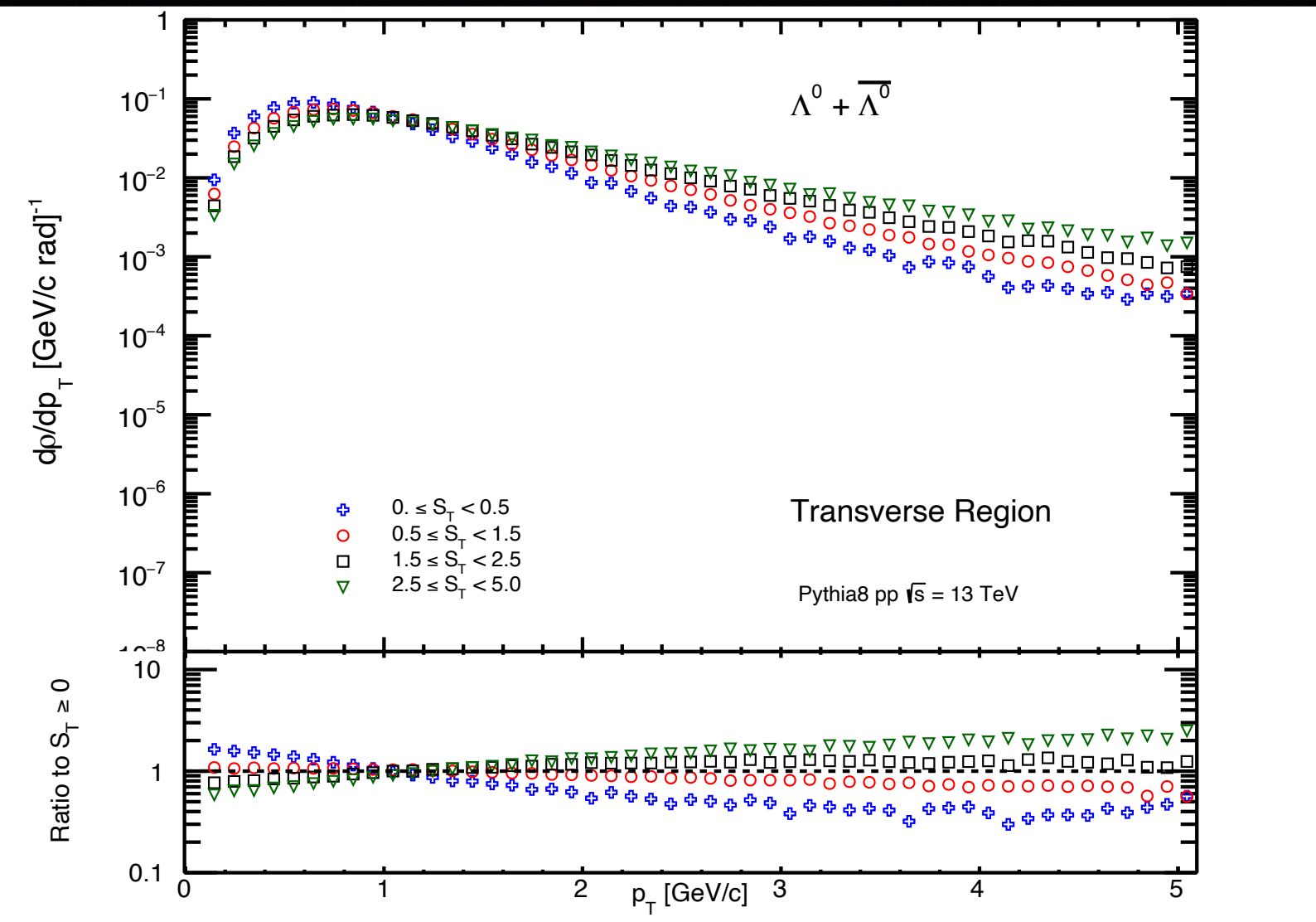
p_T distribution : pions



p_T distribution : kshort



p_T distribution : lambda



Summary

Significant efforts in both experimental and theoretical side to improve our understanding of QCD

LHC has provided access to a large phase space for understanding of various aspects of QCD

The new transverse activity classifier is introduced to understand the UE