Latest Minimum Bias and Underlying Event Measurements at ATLAS

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On behalf of ATLAS collaboration

MPI@LHC, Shimla, December 11-15, 2017

National Research Foundation

ATLAS EXPERIMENT

CERN

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

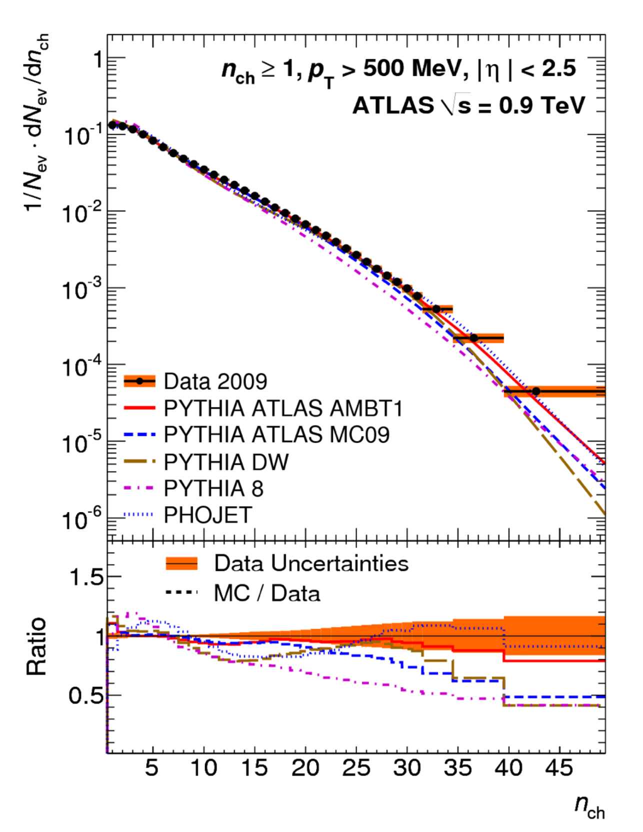
Glossary

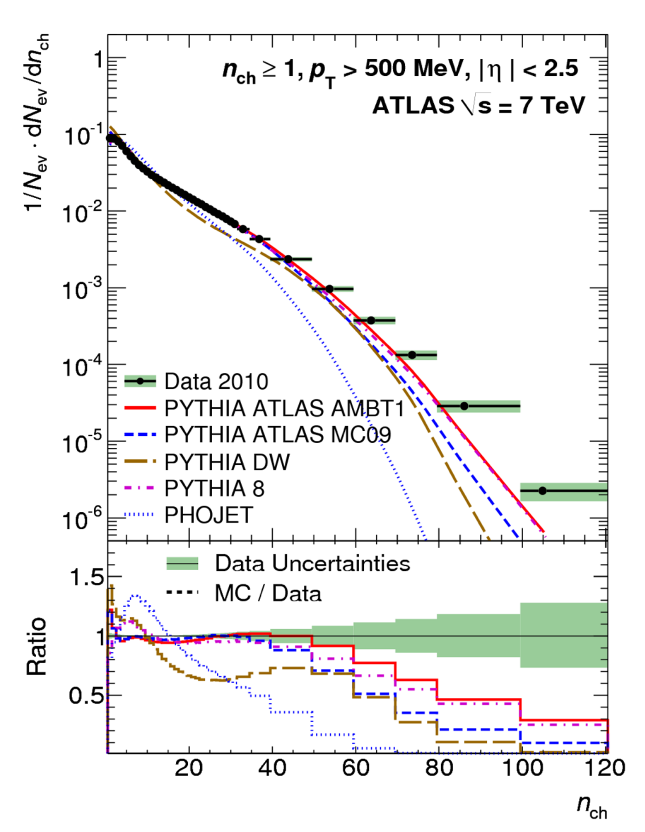
- Minimum-bias (MB): Pretty much everything, exact definition trigger dependent.
- Underlying event (UE): everything except the hard scattered partons, pedestal activity to events with an identified hard scatter (more like the actual interesting events we want to look at)
- Pileup (PU): (uncorrelated) separate collisions within the same/different bunch crossing we can't differentiate because of our finite detector resolution (more like "isotropic" min-bias events).

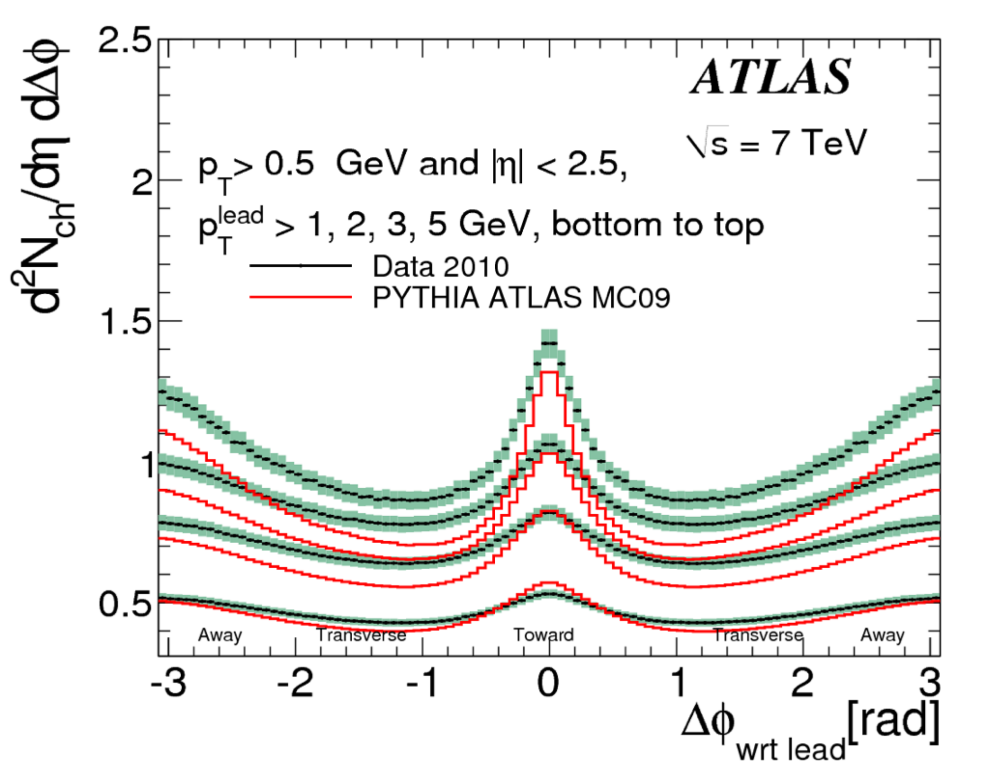
Prologue

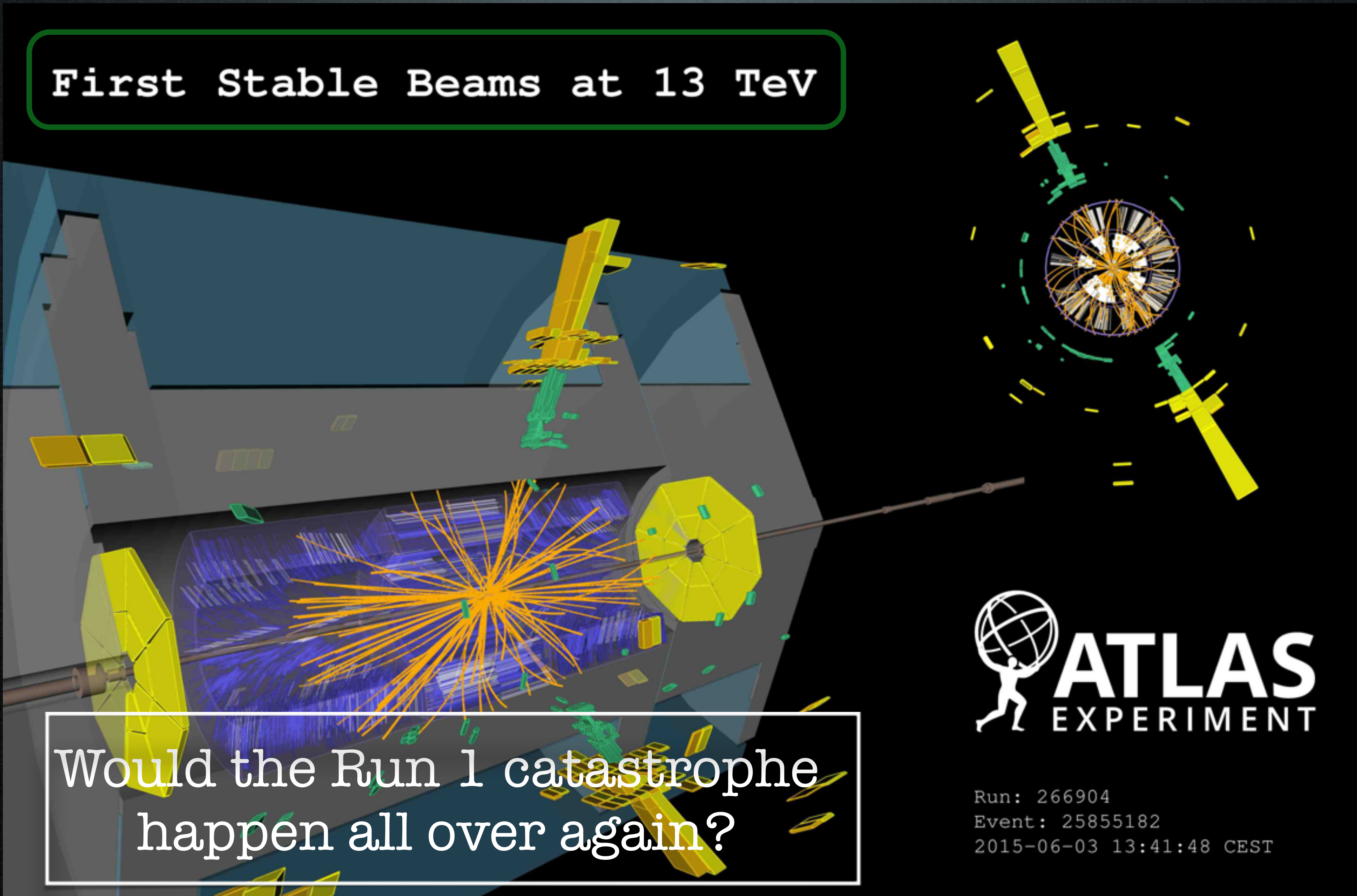
At the start of Run 1:

- Tevatron tunes did not agree with the early minbias and underlying event data.
- Not just at 7 TeV, but also at 900 GeV!





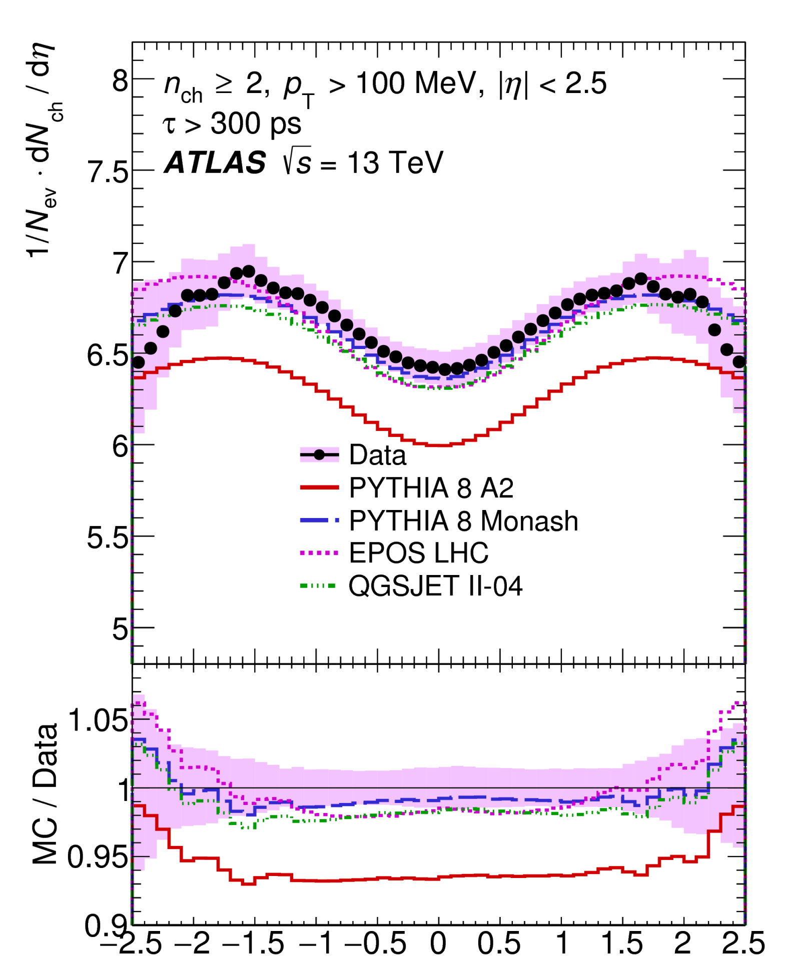



First Stable Beams at 13 TeV
Would the Run 1 catastrophe happen all over again?
ATLAS
EXPERIMENT
Run: 266904
Event: 25855182
2015-06-03 13:41:48 CEST

Charged Particle Pseudorapidity

Higher transverse momentum threshold

13 TeV!



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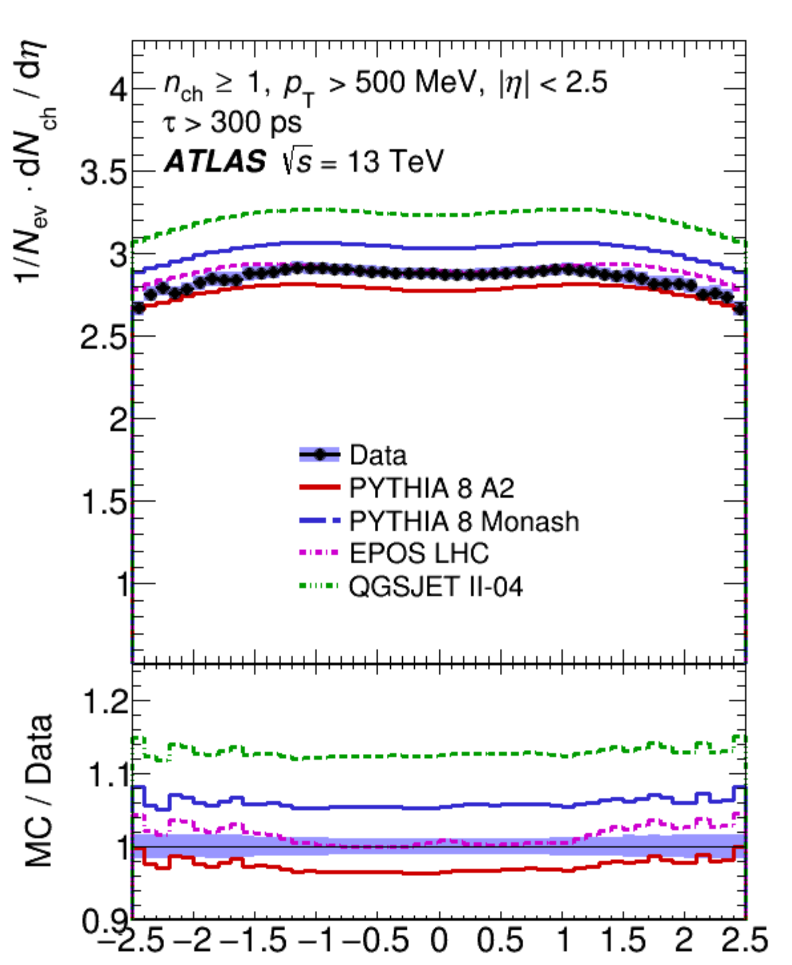


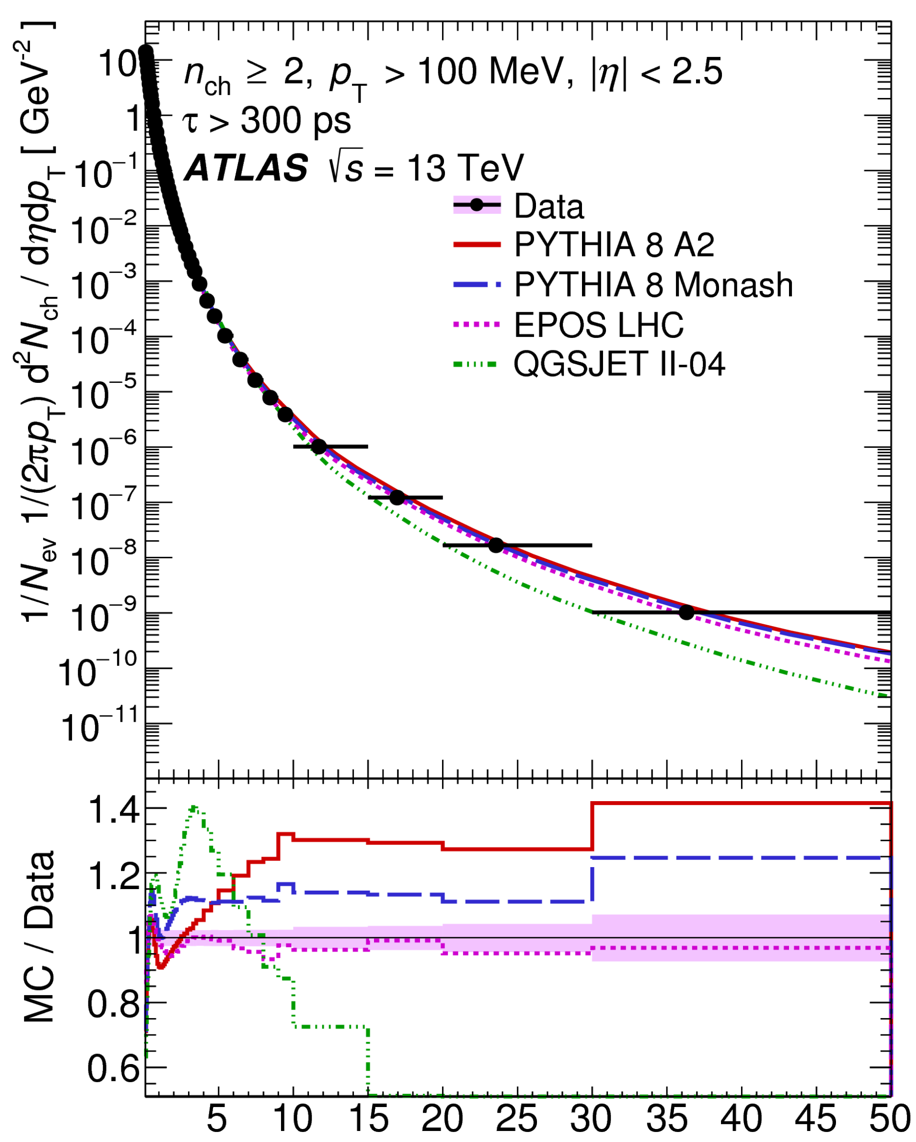
Physics Letters B (2016), Vol. 758, pp. 67-88

Overall Epos is the best, stark difference in A2 predictions going from 100 to 500 MeV

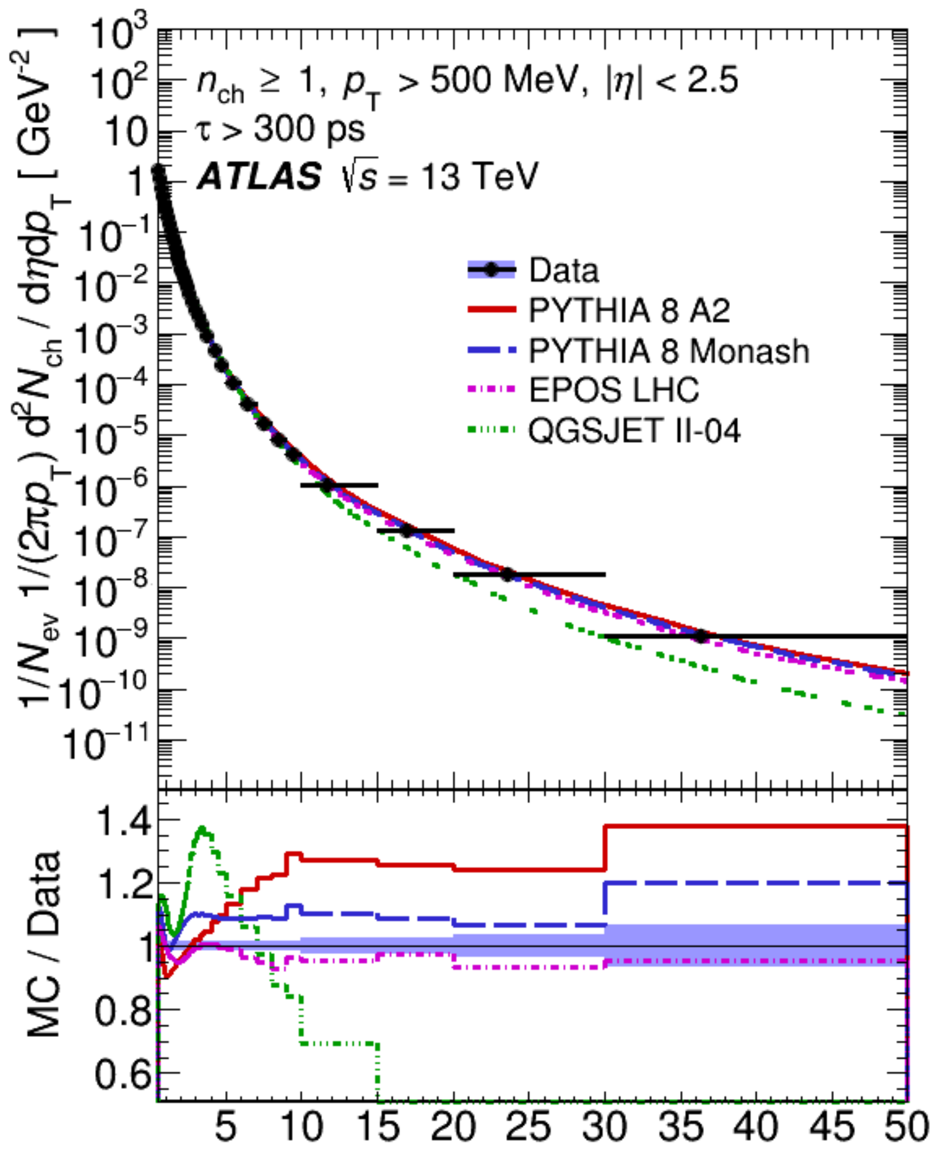
Charged Particle Transverse Momentum

Higher transverse momentum threshold

13 TeV!



Eur. Phys. J. C 76 (2016) 502



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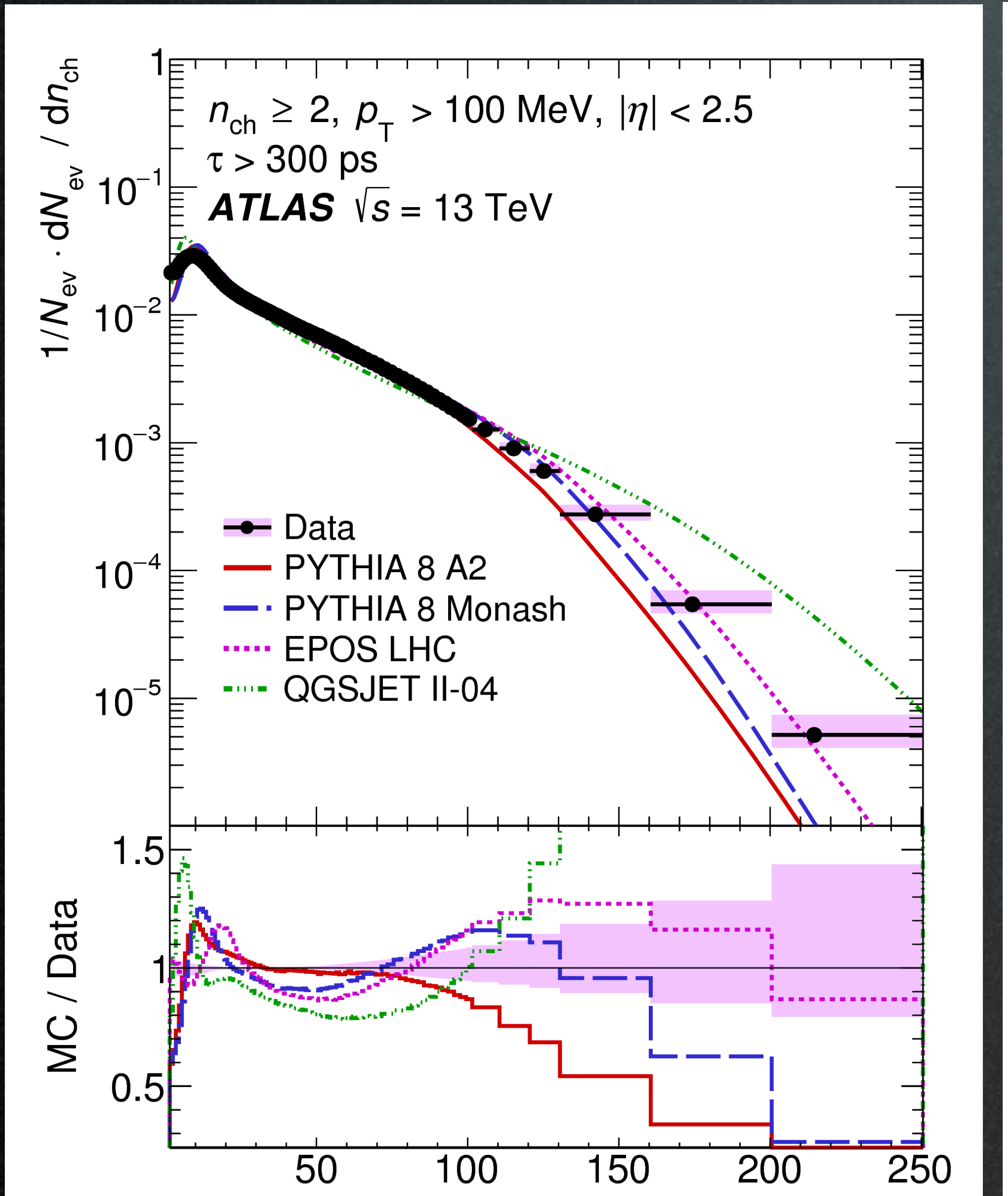
Epos is best for both

A2 and Monash are competitive but not over the full range

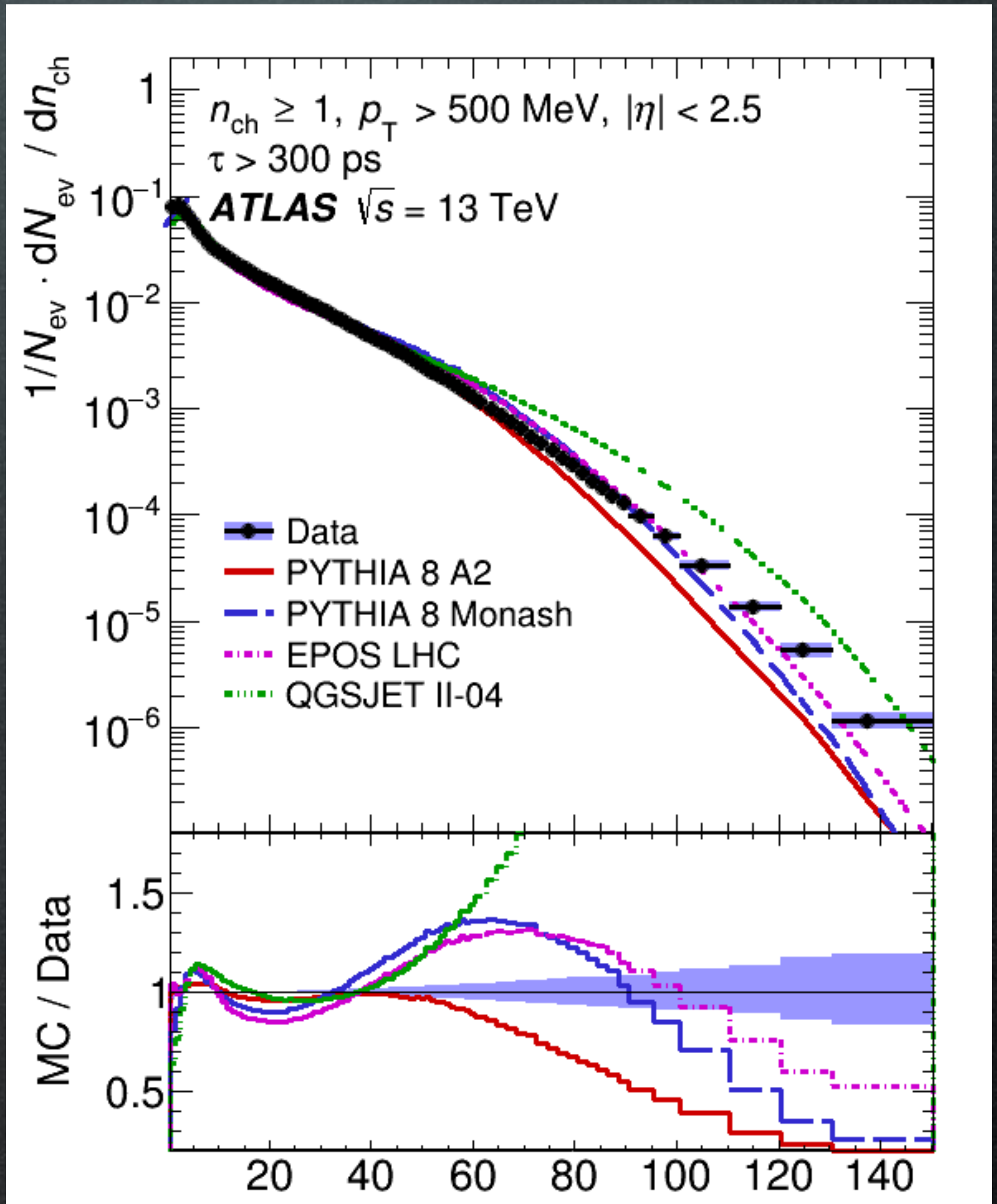
Charged Particle Multiplicity

Higher transverse momentum threshold

13 TeV!



Eur. Phys. J. C 76 (2016) 502



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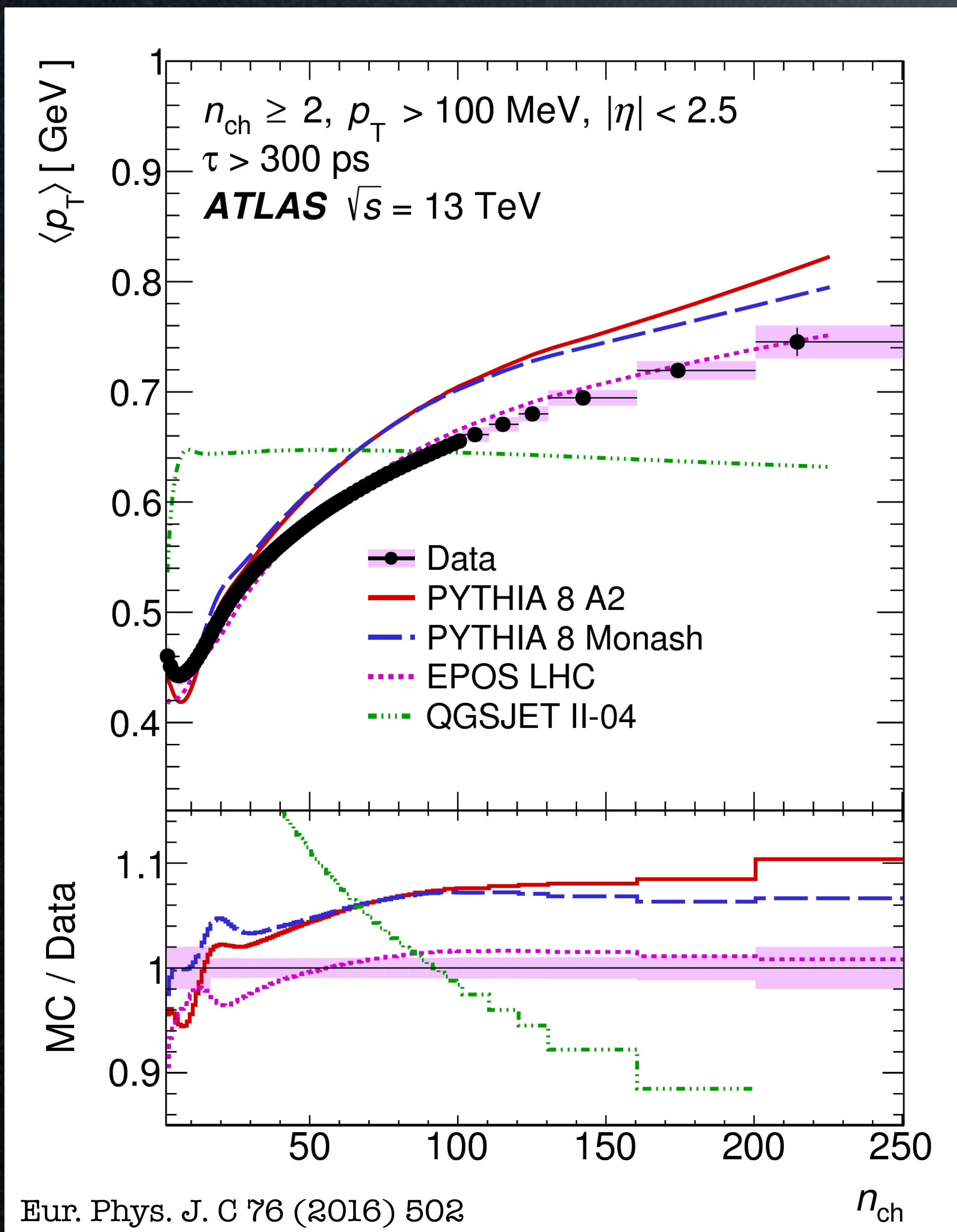
Similar trends

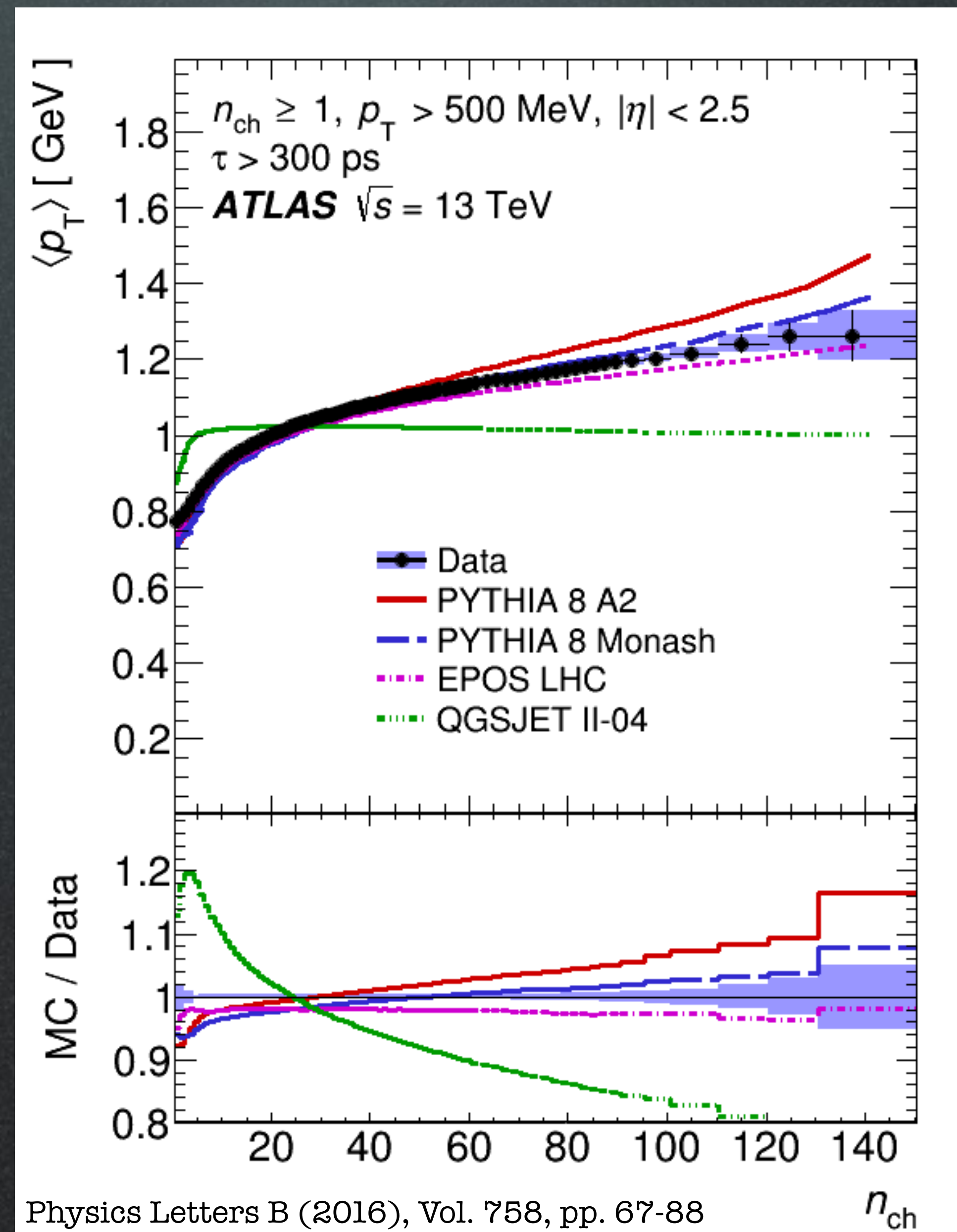
None of the models do well over the whole range

Mean Transverse Momentum against Multiplicity Correlation

Higher transverse momentum threshold

13 TeV!

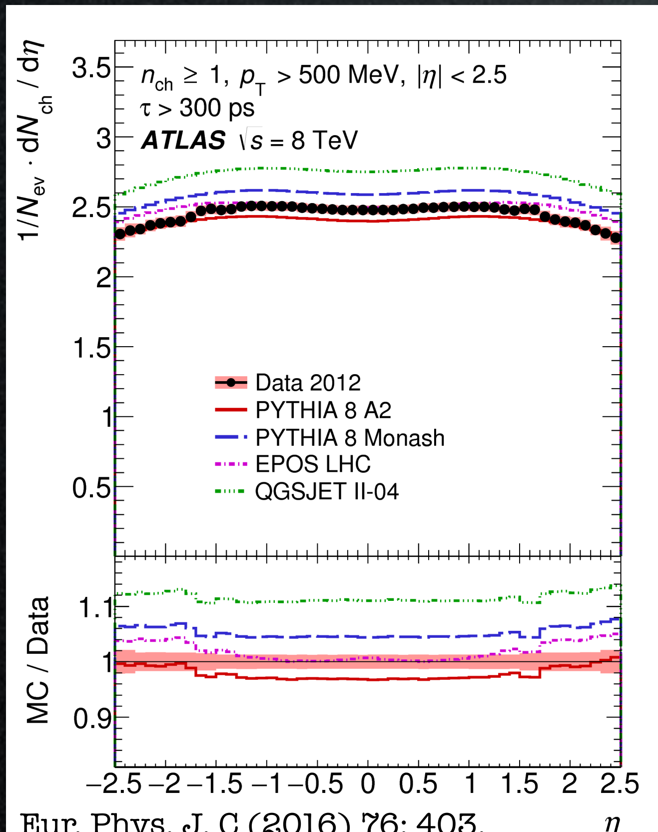




Correlation depends on colour reconnection

Better modelled at 500 MeV, QGSJETII has no CR

Charged Particle Distributions at 8 TeV



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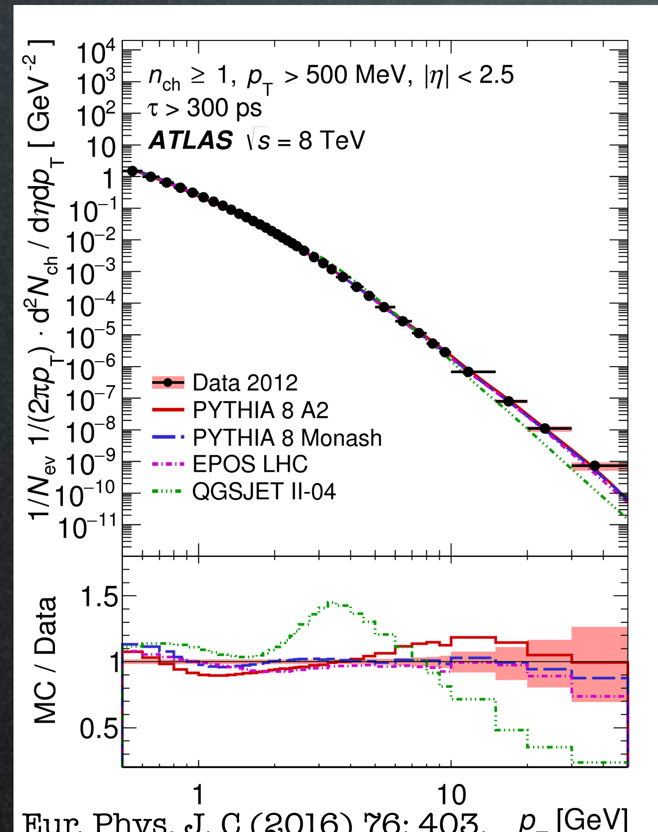

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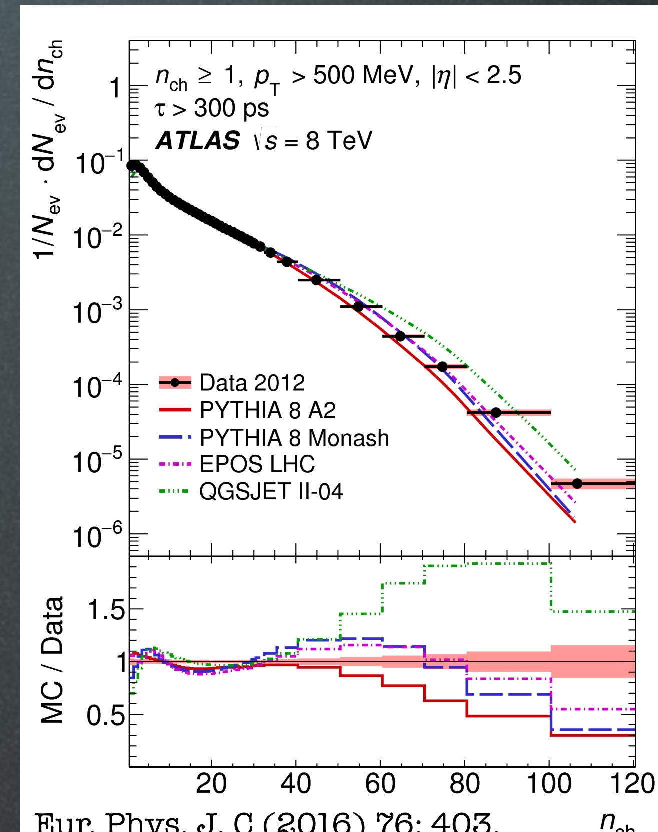

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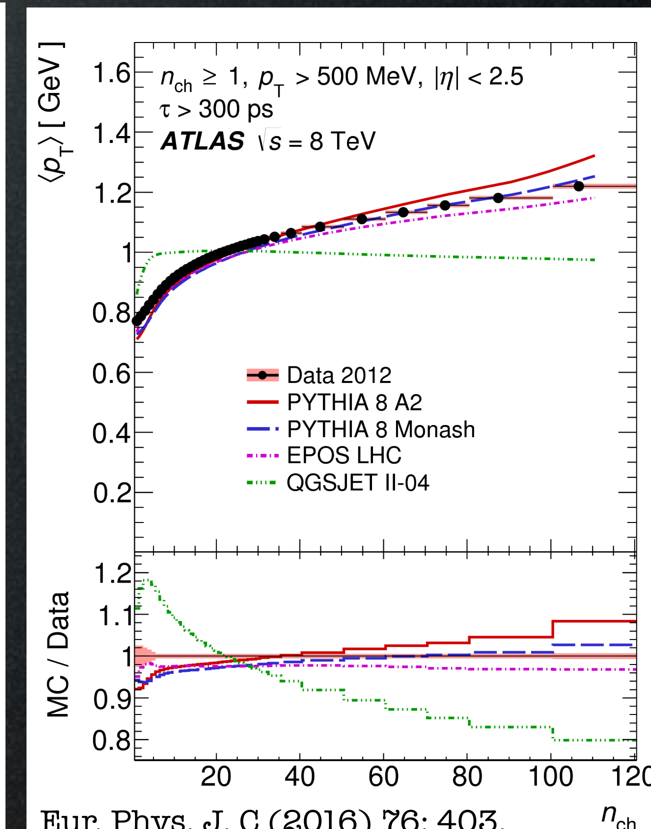

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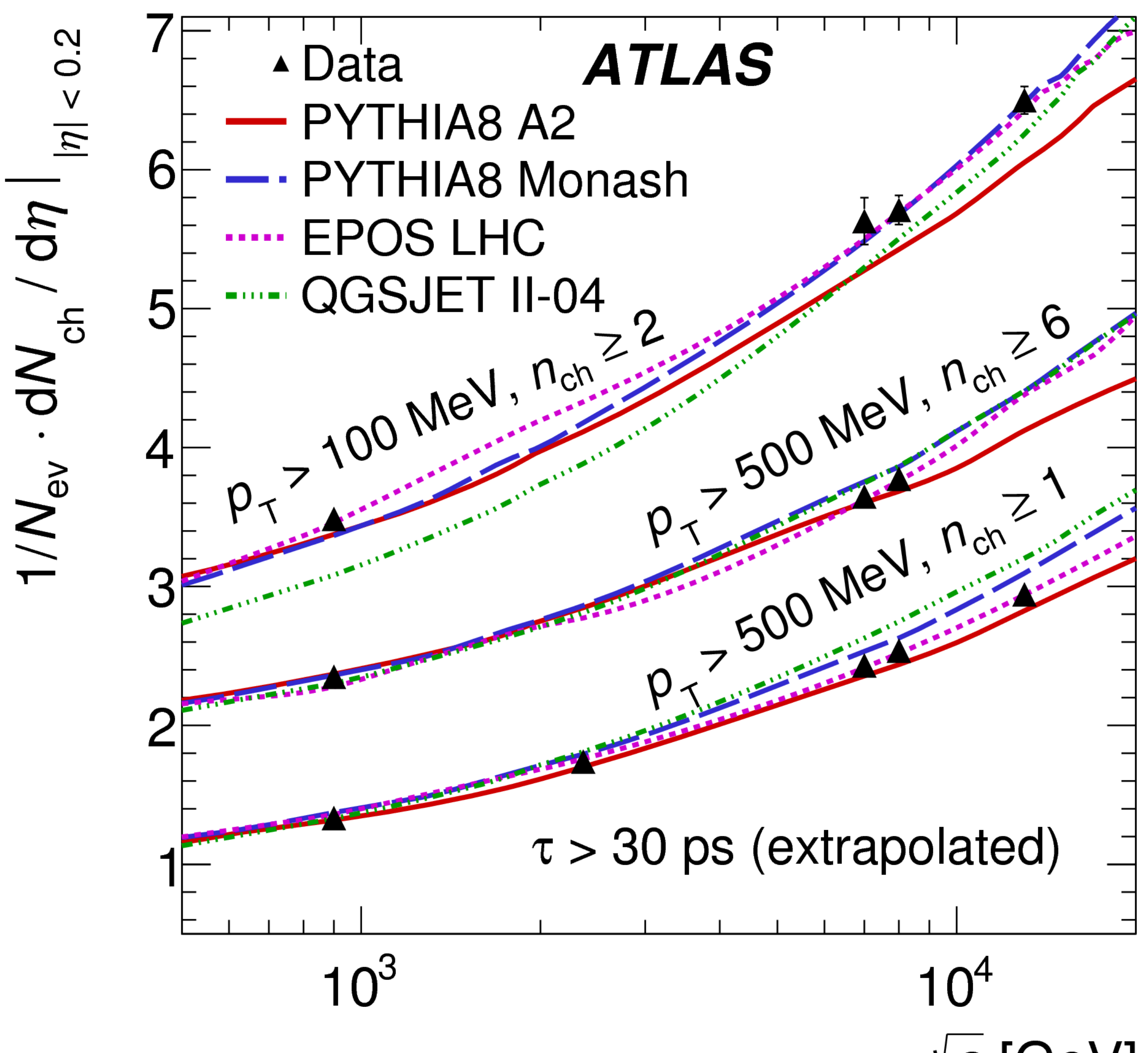
- Models show discriminating power
- Results available for different phase spaces

Dependence on E.C.M



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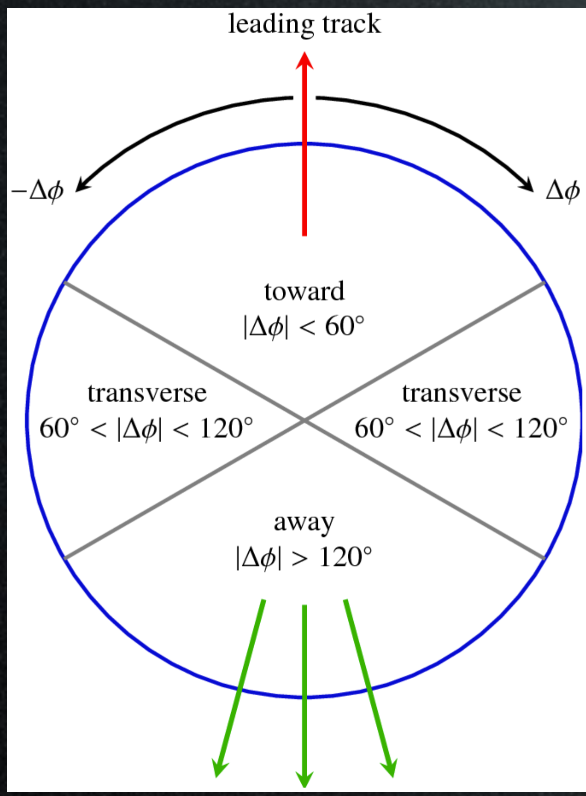
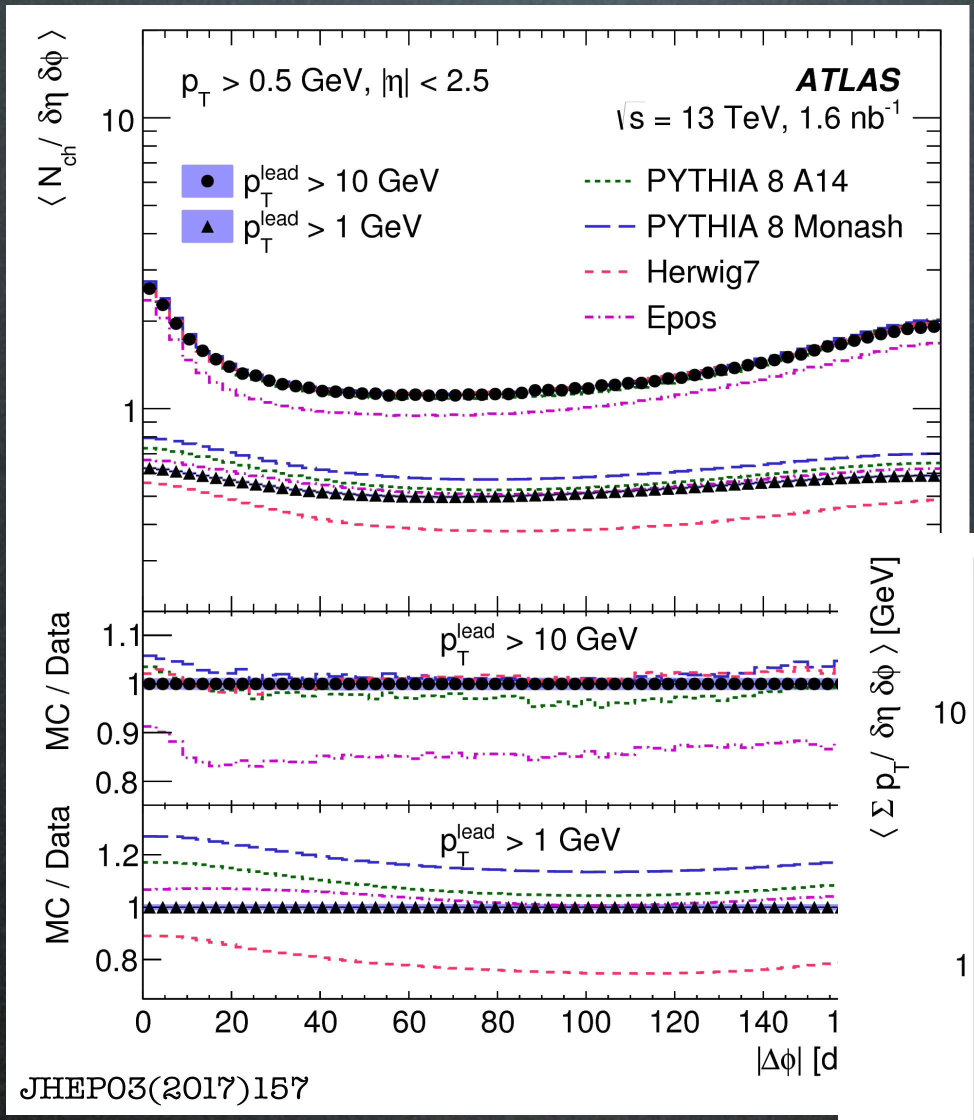
About 20% increase from going from 7 to 13 TeV

Most models get the energy extrapolation trend right

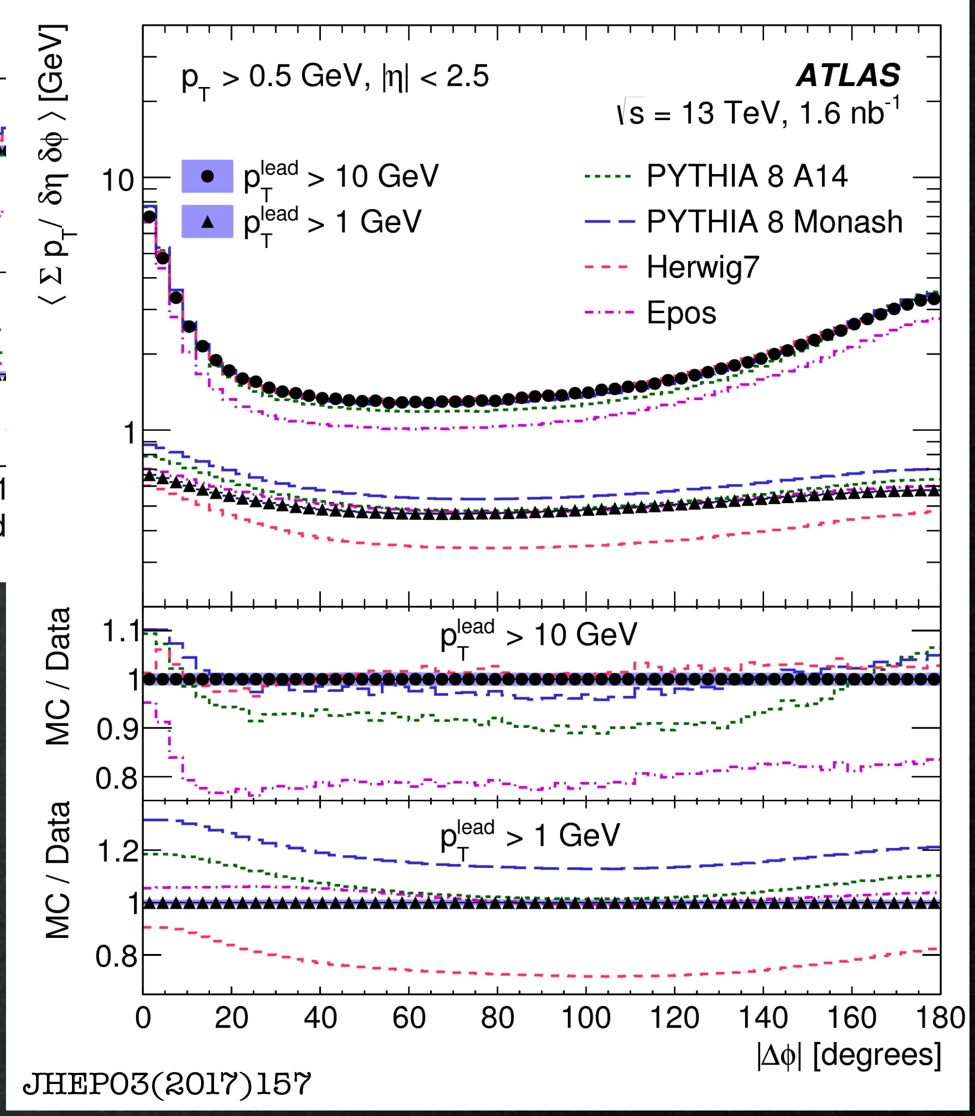
Underlying Event

13 TeV!





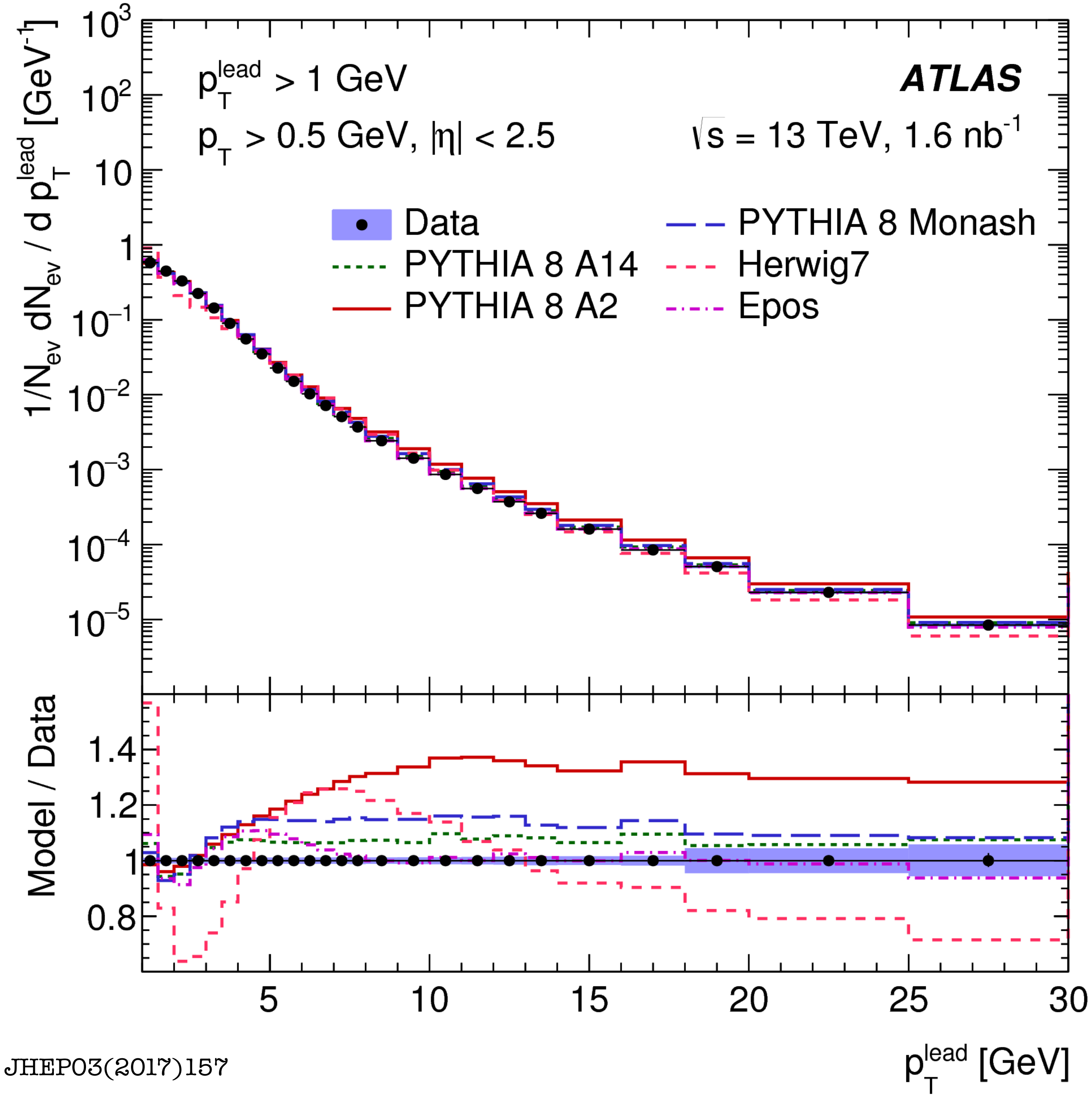
Transition from relatively isotropic MB scattering to the emergence of harder UE



Overall decent agreement, MB tunes do better for lower lead p_T, while UE tunes are better for higher slices

Leading Charged Particle

13 TeV!



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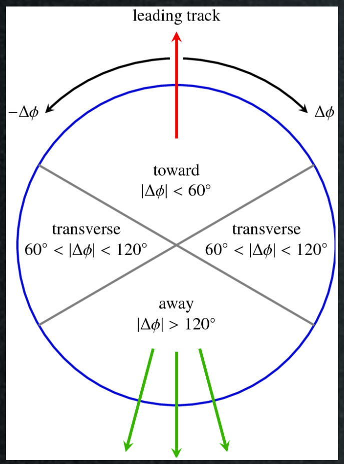
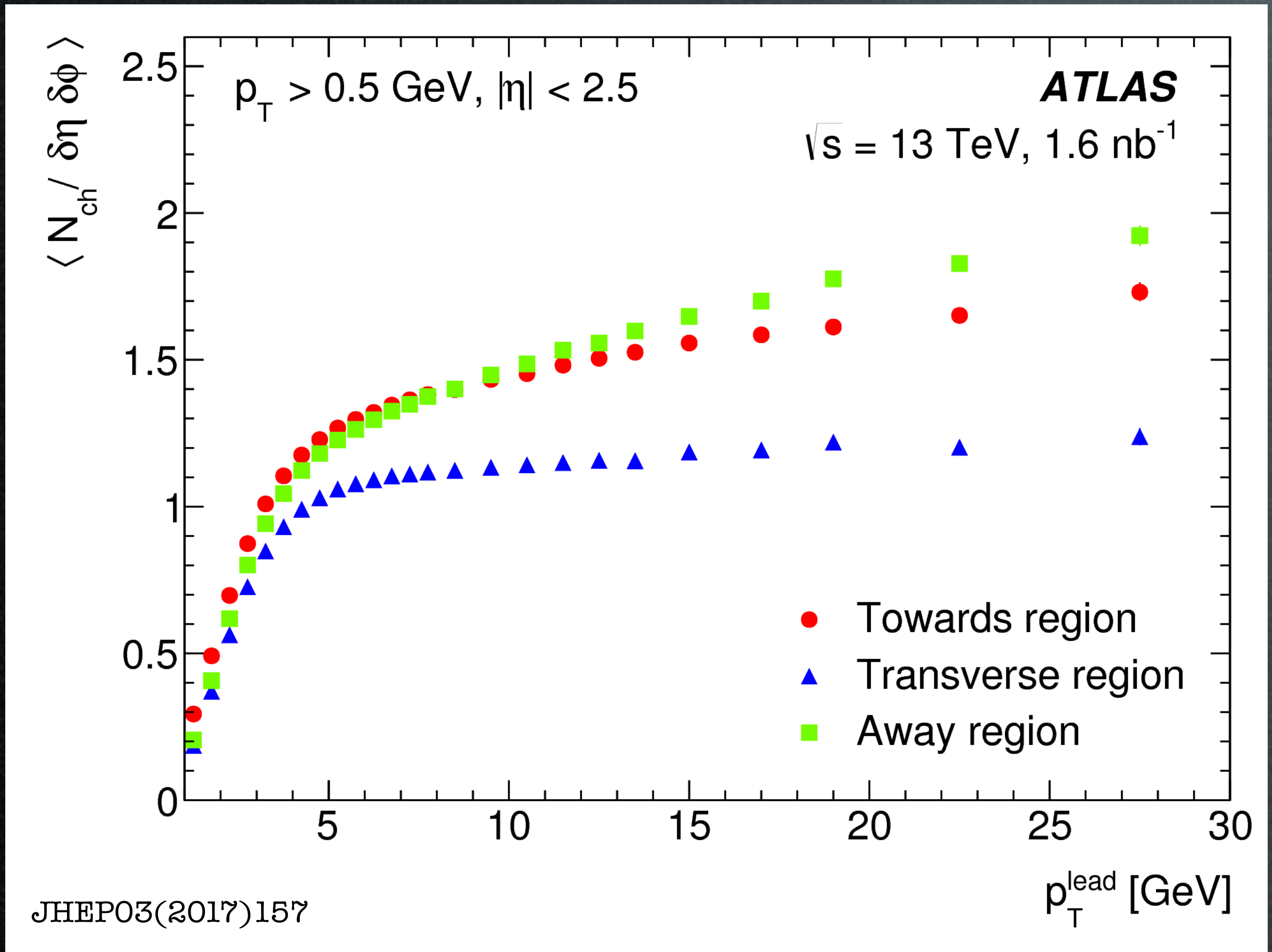
Best modelled by Pythia8 A14/Monash

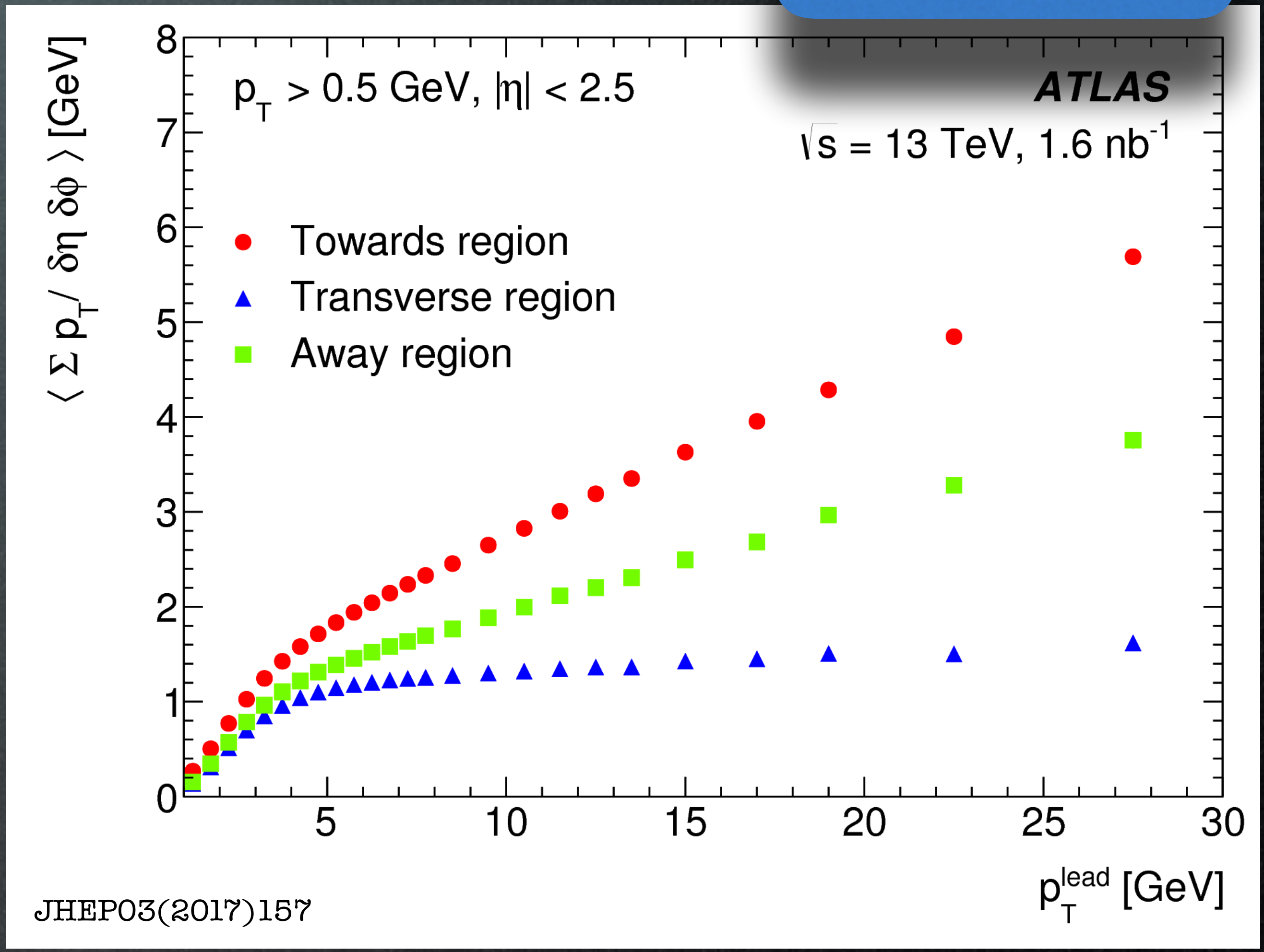
Others have somewhat different shapes



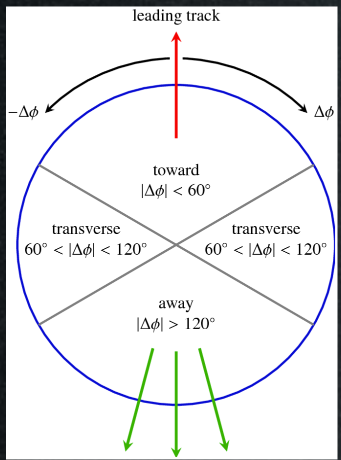
Comparison of Regions I

13 TeV!



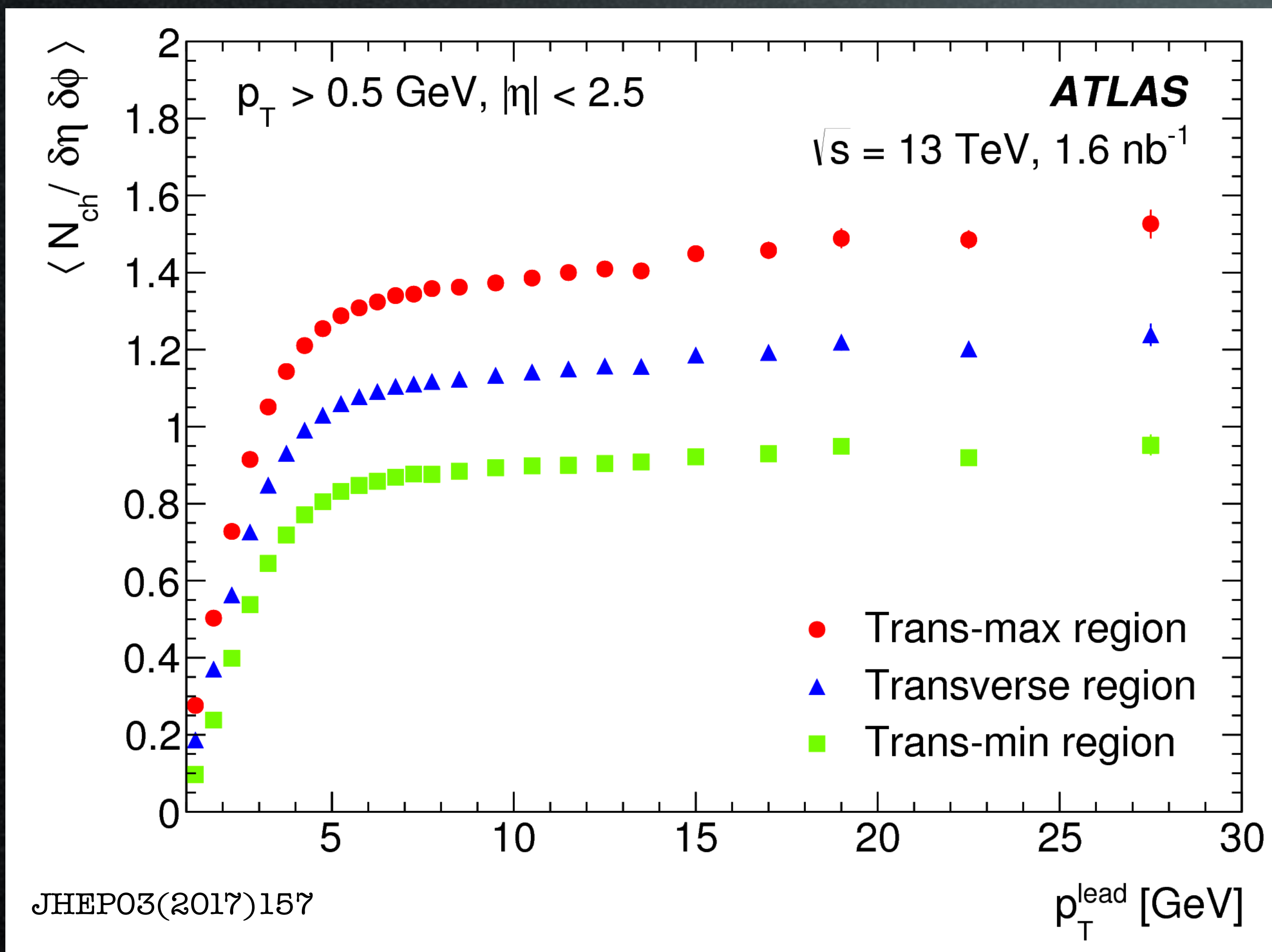


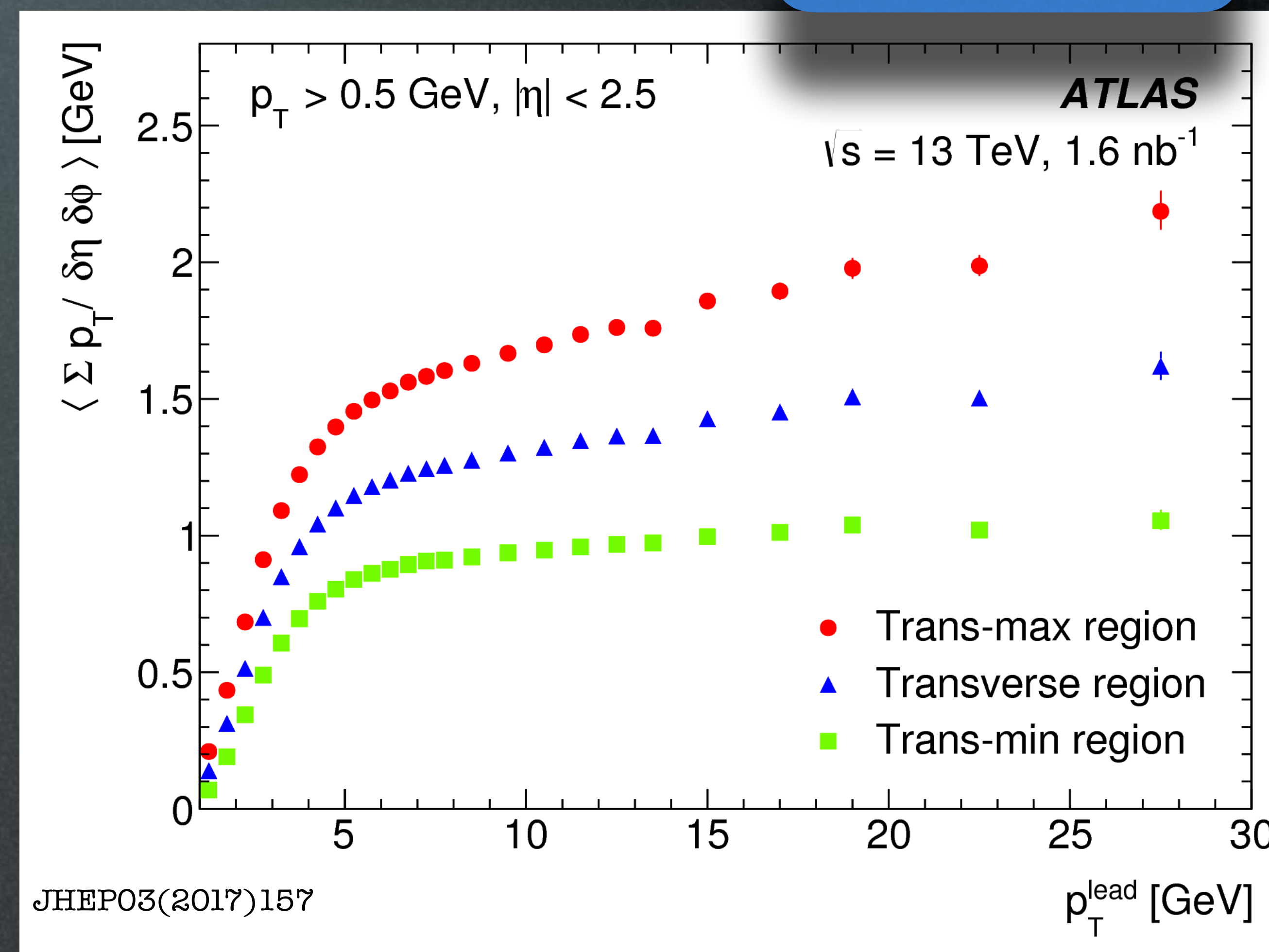
Characteristic plateau at transverse region, cross-over for away



Comparison of Regions I

13 TeV!

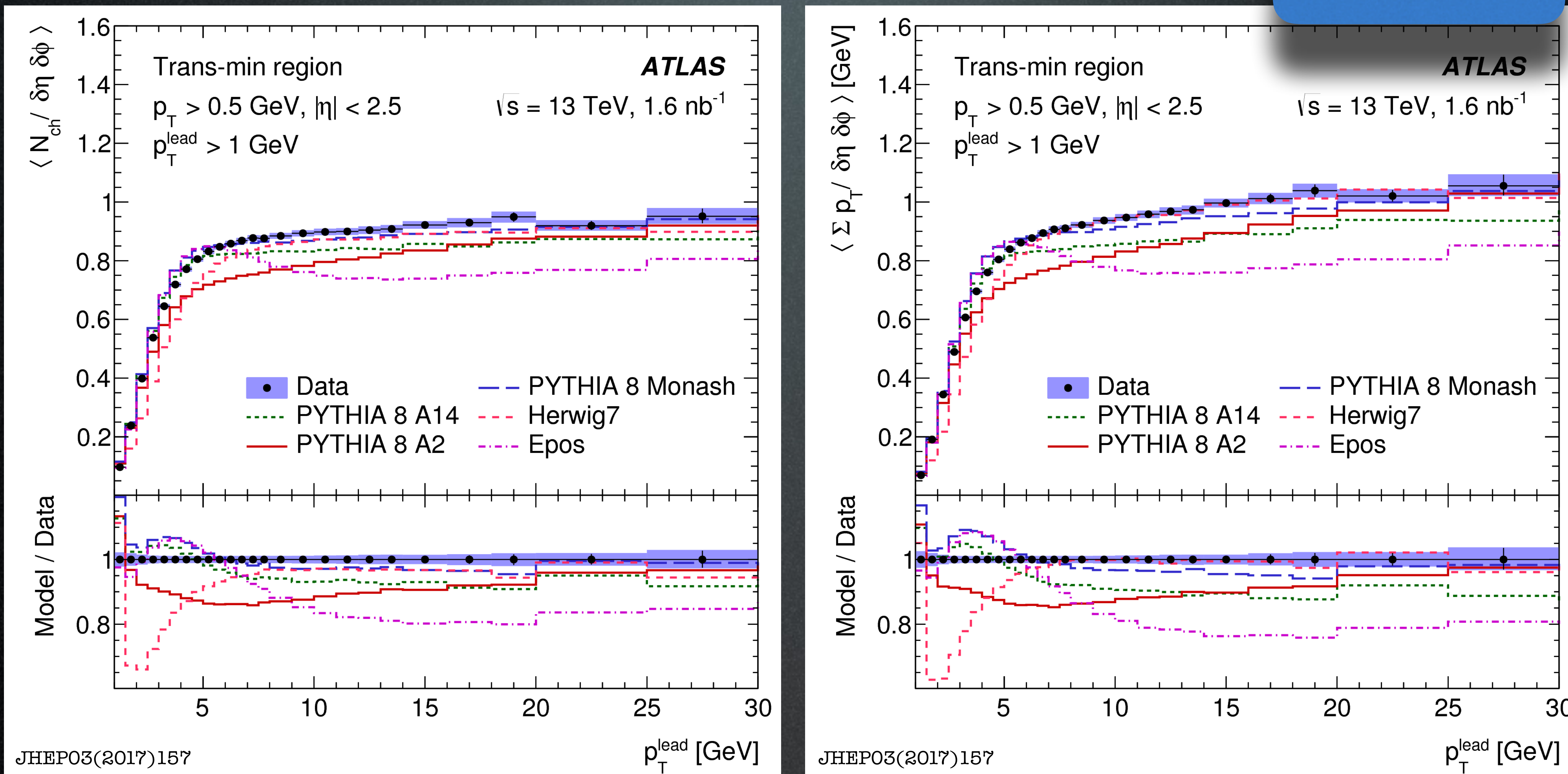




Max/Min/Diff sensitive to different aspects of the UE. Trans-min most sensitive to UE, trans-max gets UE and hard jet contamination, and trans-diff is dominated by extra hard jets.

Trans-min Region I

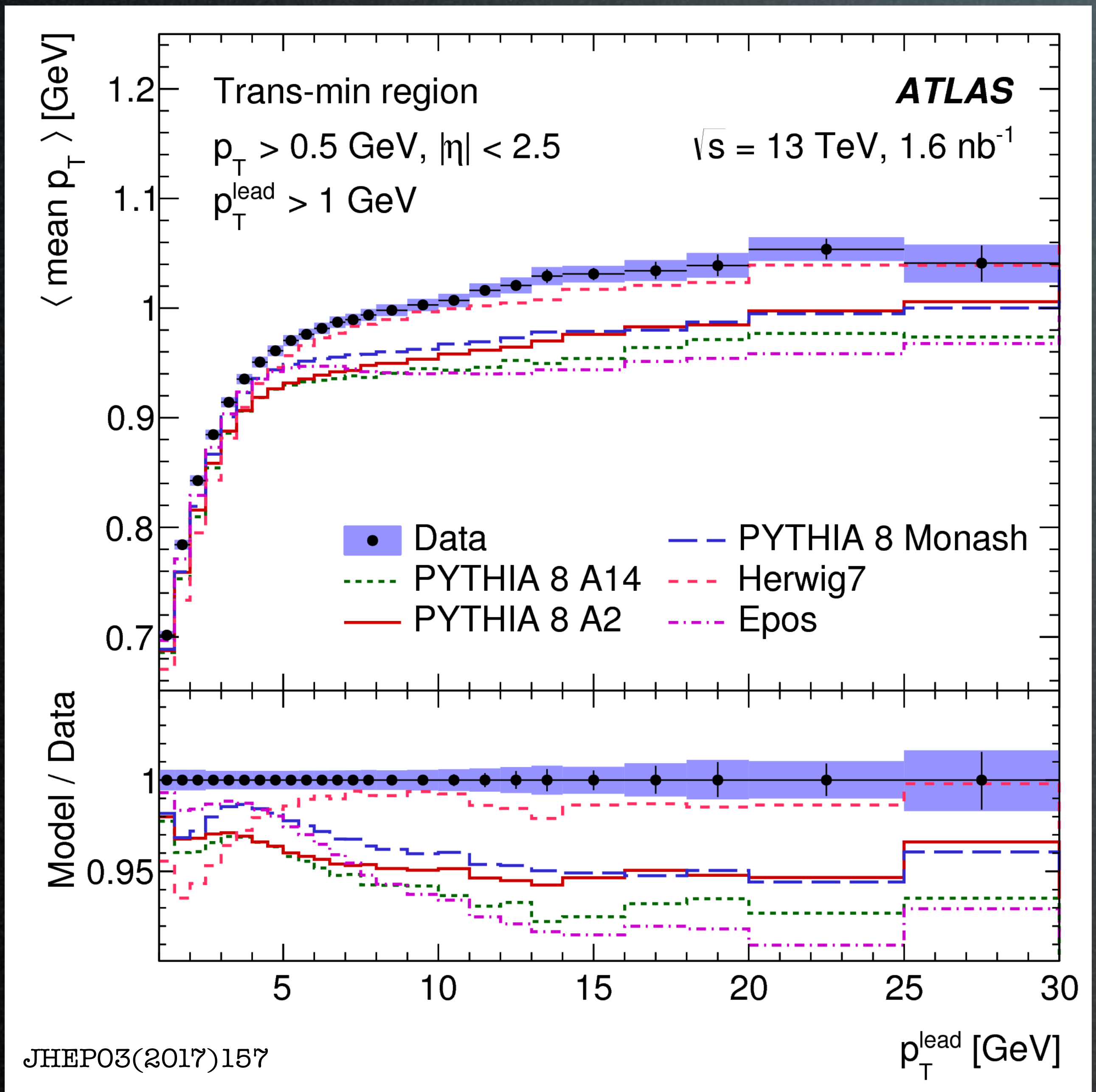
13 TeV!

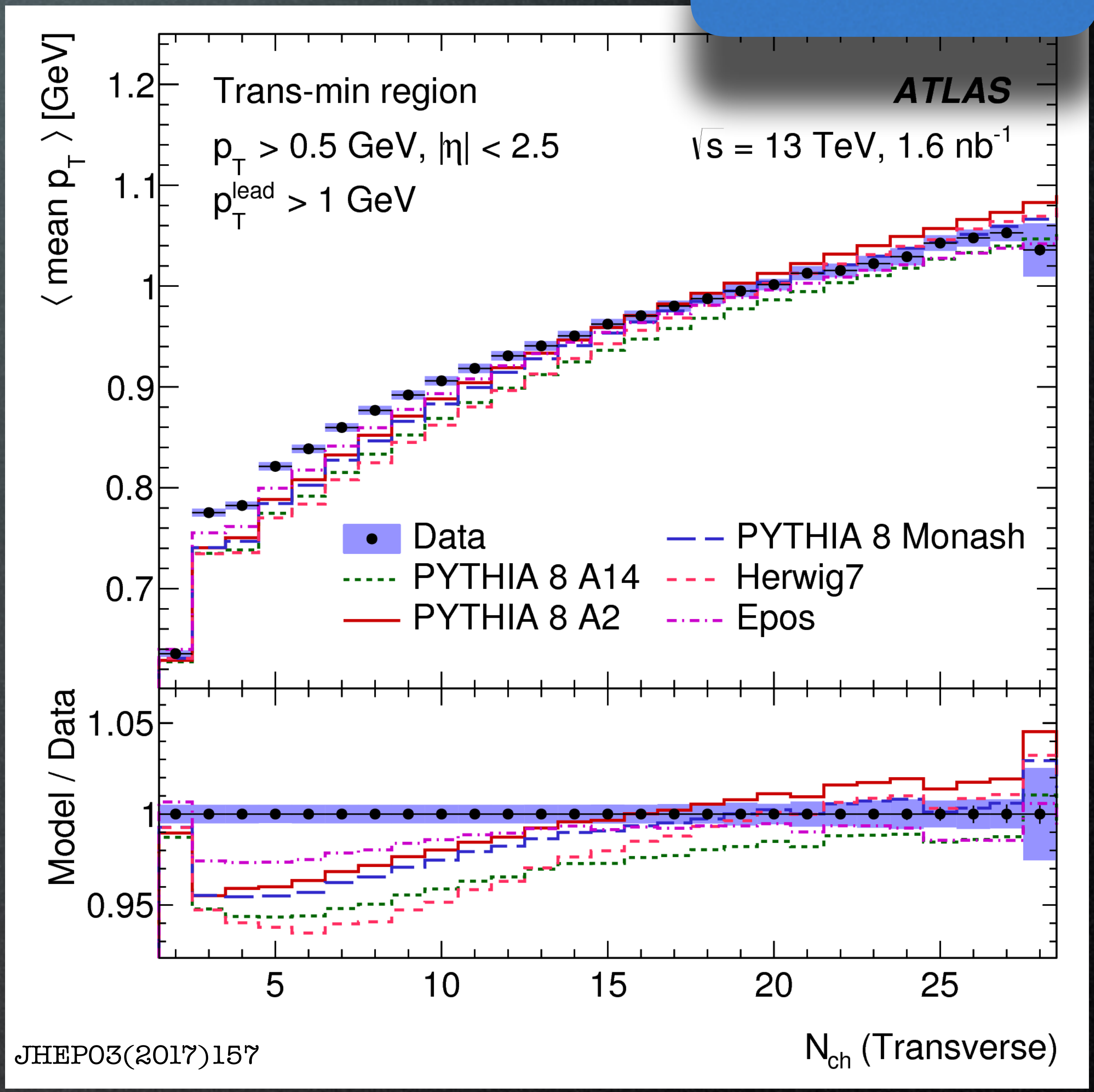


Best described by Pythia8 Monash and Herwig7

Trans-min Region II

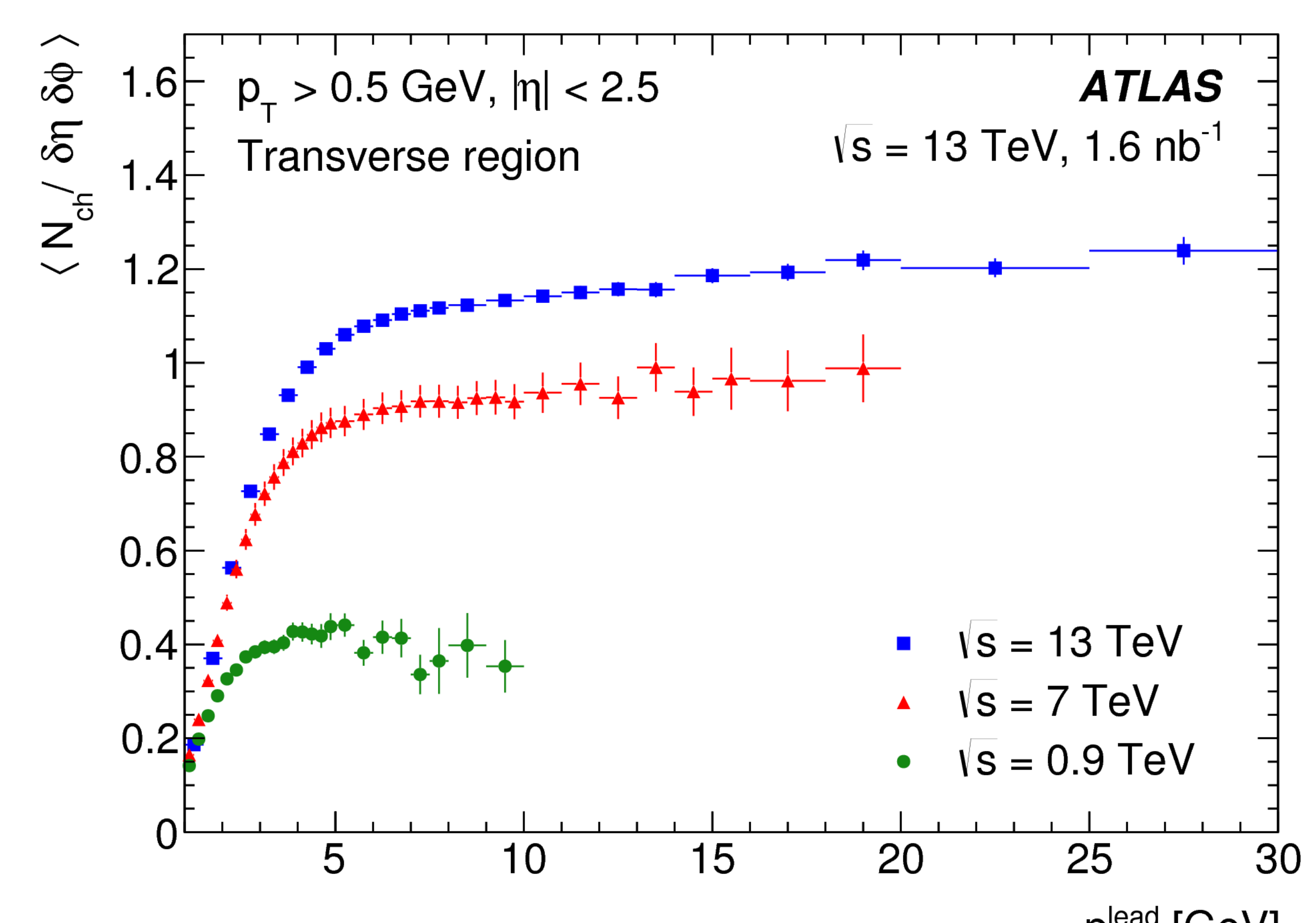
13 TeV!





Correlation is sensitive to CR, underestimated at low multiplicity by all models

Evolution with Collision Energy



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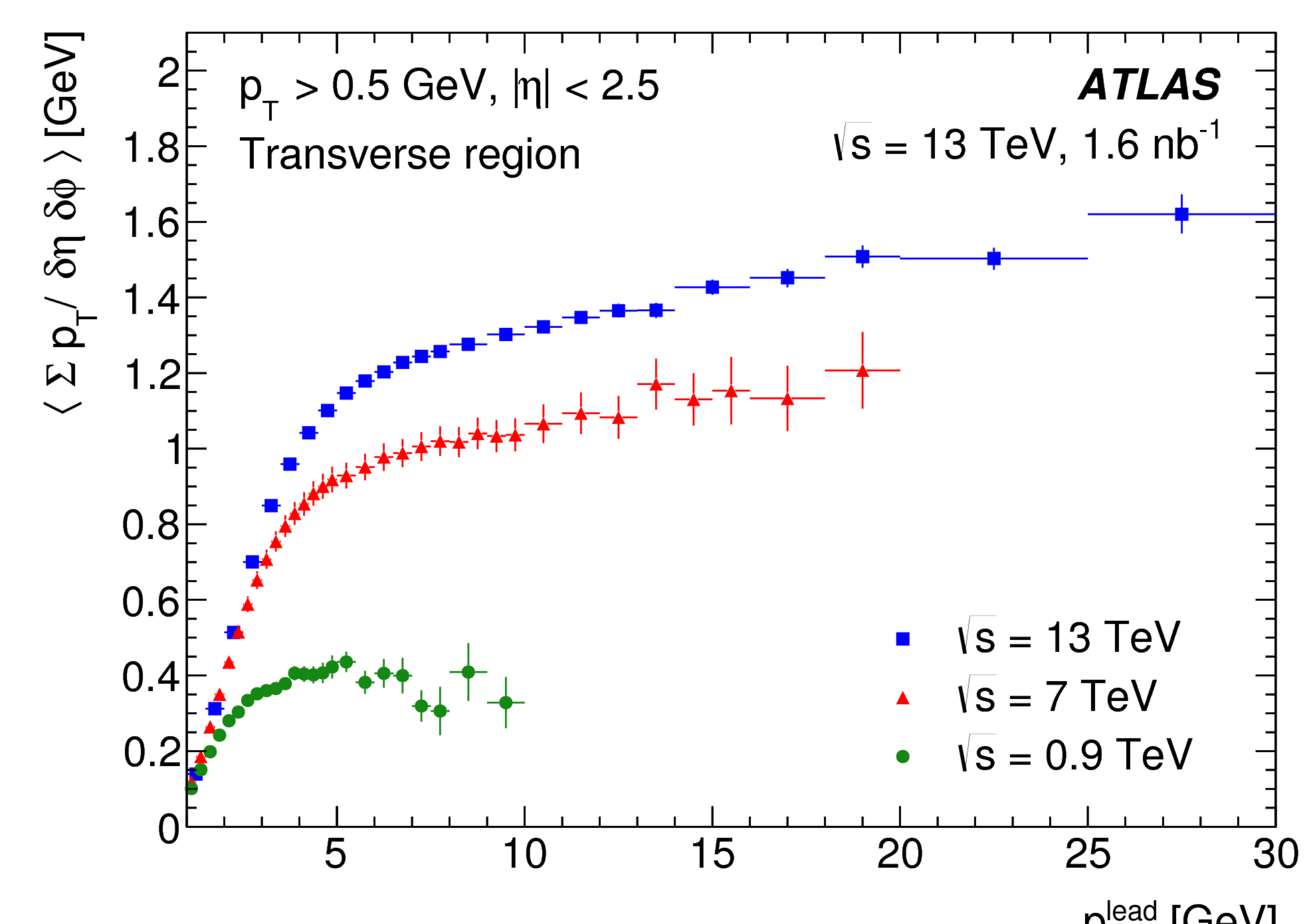

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Summary

- Run 2 MB and UE measurements showed better MC modelling compared to early Run 1
- Predicted collision energy dependence was seen as well.
- Tension between MB and UE tunes remain.
- Standard UE measurements are contaminated by hard scatter, so alternative measurement strategies are needed if modelling of MPI/CR to be improved.

Epilogue

OLIVE BROOK
$T^{\mu\nu} = (\rho + p) U^\mu U^\nu + p \eta^{\mu\nu}$
Crafter's Choice
750cm³ Sémillon
EXCLUSIVE
COLLECTION