Measurement of the UE activity in pp collisions with the CMS and ATLAS detectors

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MPI@LHC 2013 - Antwerp

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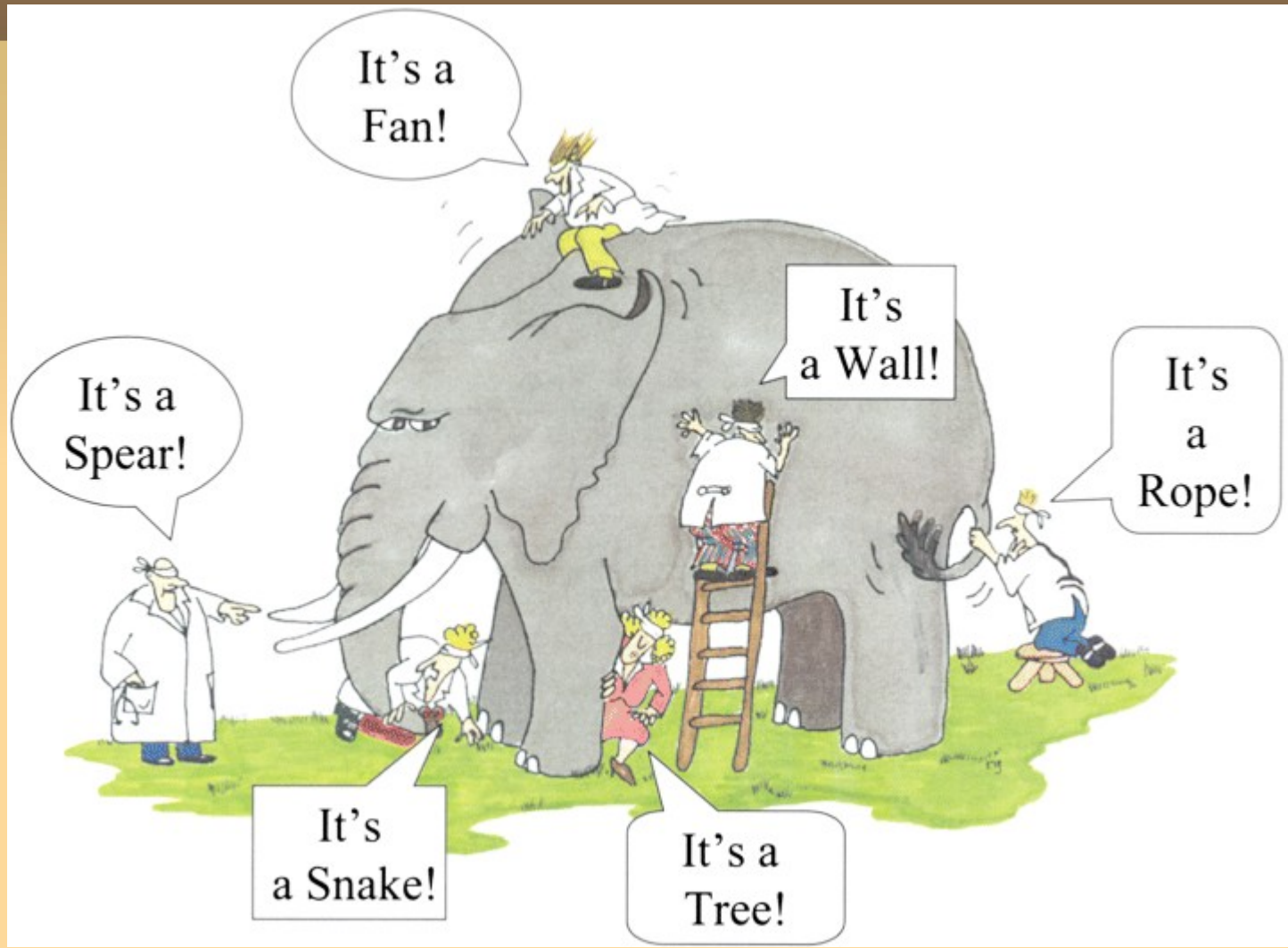
Outline

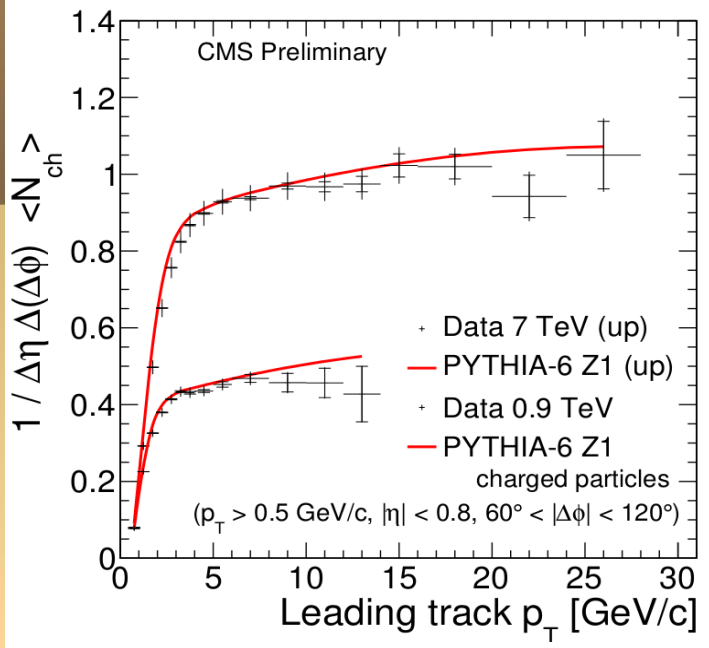
- Since the first beam collisions at the LHC , there has been a tremendous effort by many groups to study the UE.
- This talk is a second look on what has been done so far.
  - Recent key results are shown.
  - Emphasis on physics.

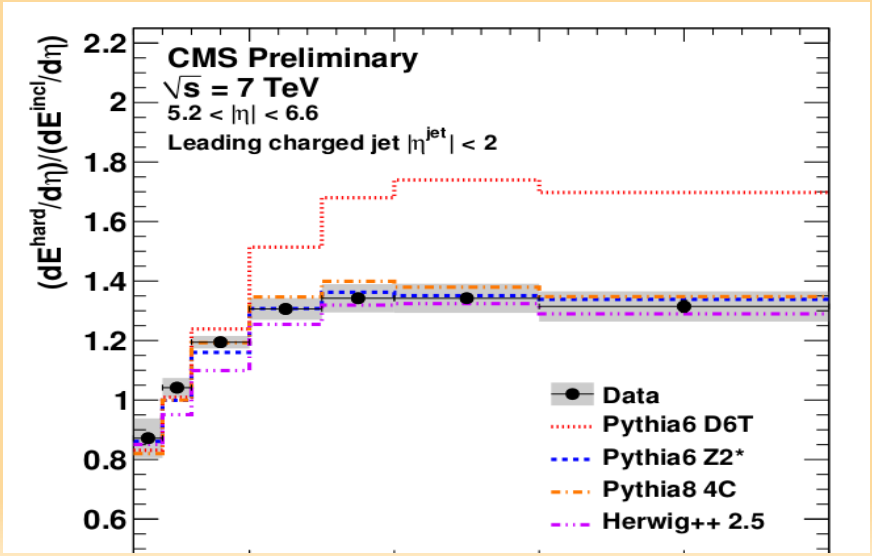
Theme

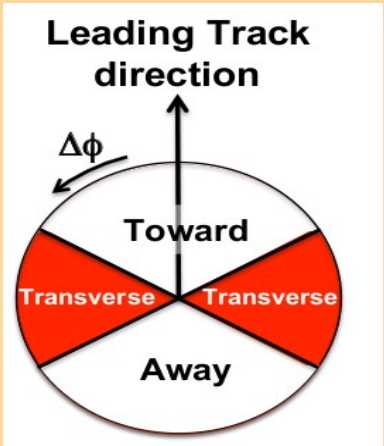


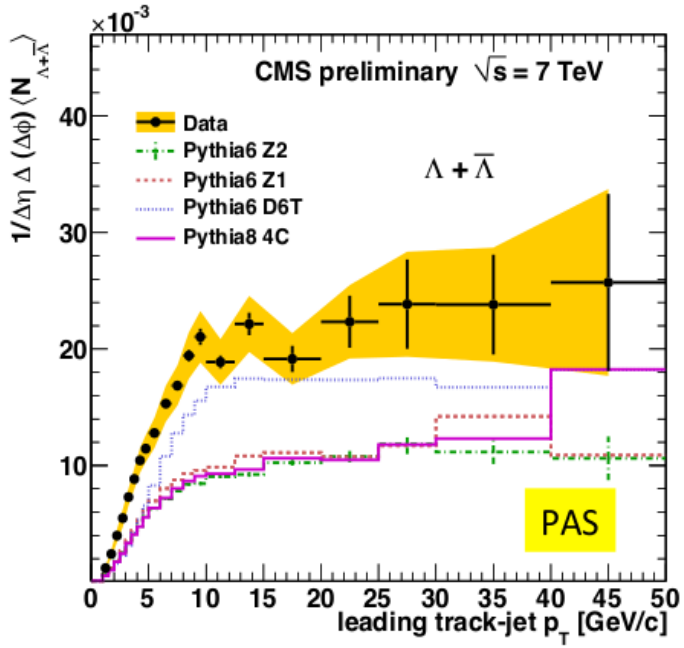
Outline (last year)

- The UE at CMS during 2012:
  - UE using the leading track.
  - Strange particles production in UE.
  - UE at forward physics.
  - Current projects.



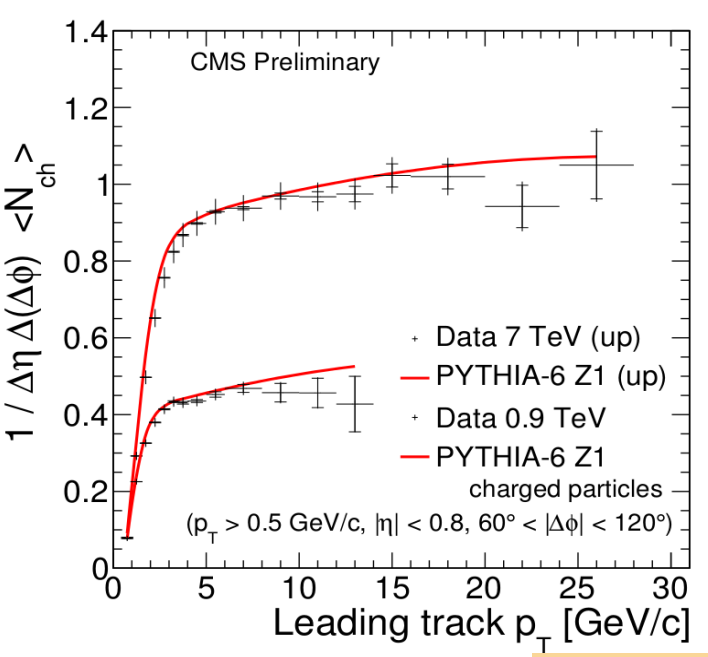


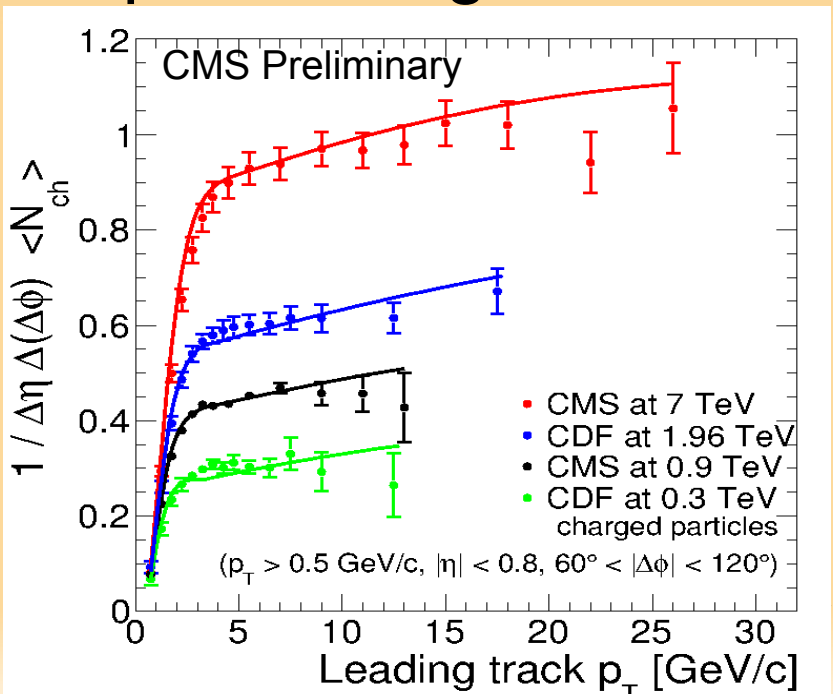


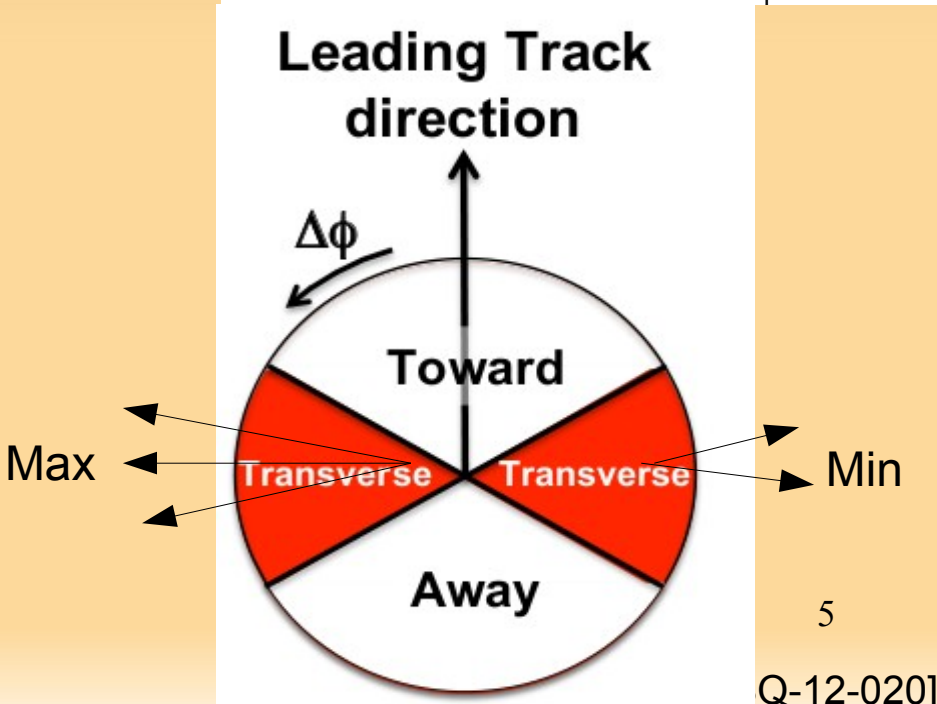


Since then...

- The UE at CMS during 2013:
  - UE using the leading track:
    - More detailed studies.
    - Complementing CDF.

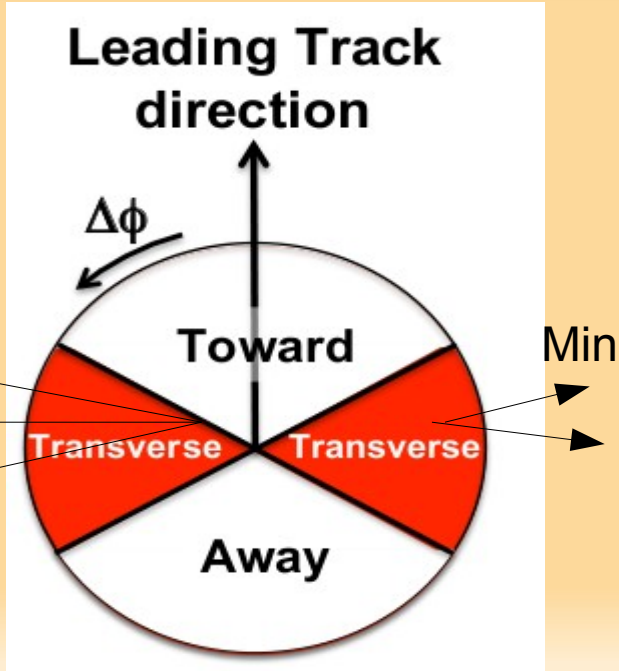






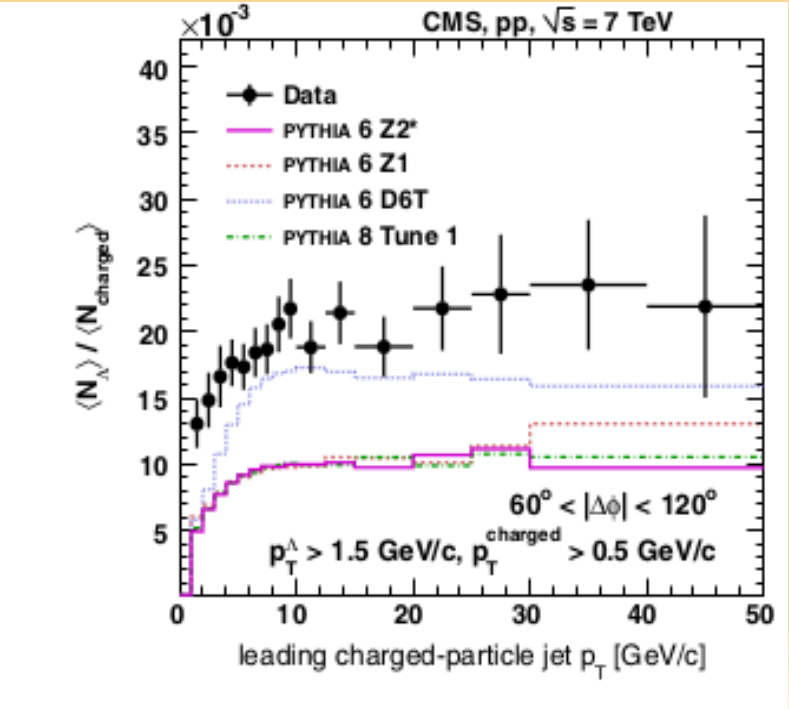
The η-φ regions in more detail

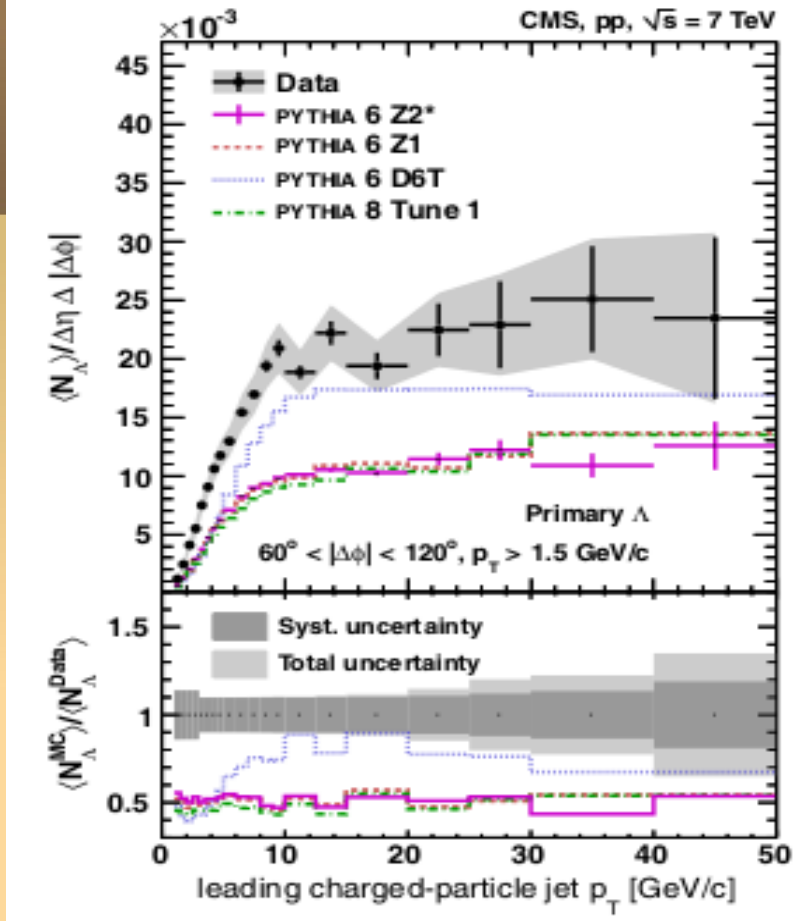
- Trans: MPI and BBR.
- Toward: Jet physics, BBR, MPI, FSR and ISR.
- Away: Jet physics (possibly), BBR, MPI, FSR, ISR and PDF.
- Max: BBR, MPI and jet physics.
- Min: BBR and MPI.
- Dif: ISR and FSR.



Strangeness at UE

The rise and saturation of the strange-particle yields and ΣpT in the UE are similar to those observed for charged particles, which confirms the impact-parameter picture of MPI.

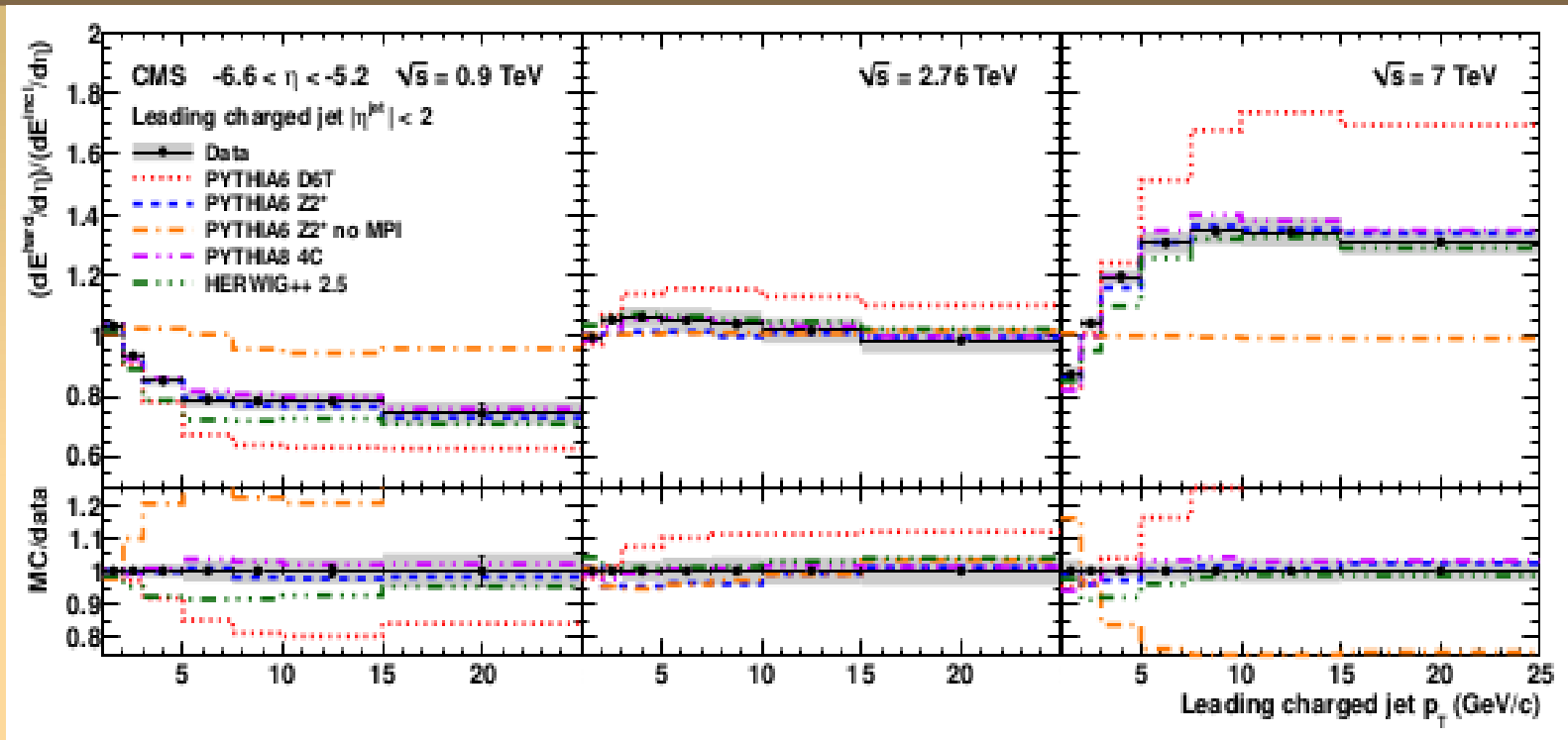




Constant strange-to-charged particle activity ratios have been measured For Ks and Λ. Indicating that hadronization and MPI are decoupled.

[PHYS. REV. D 88, 052001 (2013)]

UE at Forward physics

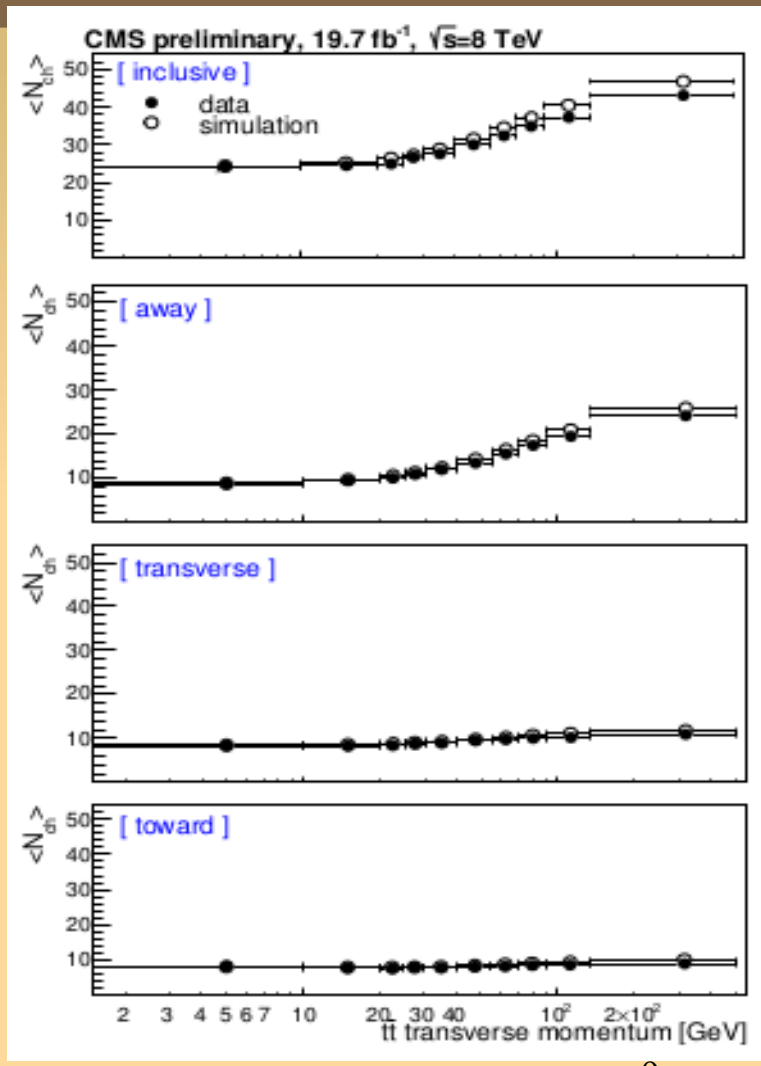


- Confirms the impact-parameter picture of MPI.
- pT ordered showers are favored by data.

[J. of High Energy Phys 04 (2013) 72]

New in 2013

- Study of the underlying event in t t(bar) events.
- Traditional approach:
  - η-φ based.
  - Observables: Nch, ΣpT, etc.
- These results will contribute to more precise measurements of the top quark mass.
- Complements DY UE.

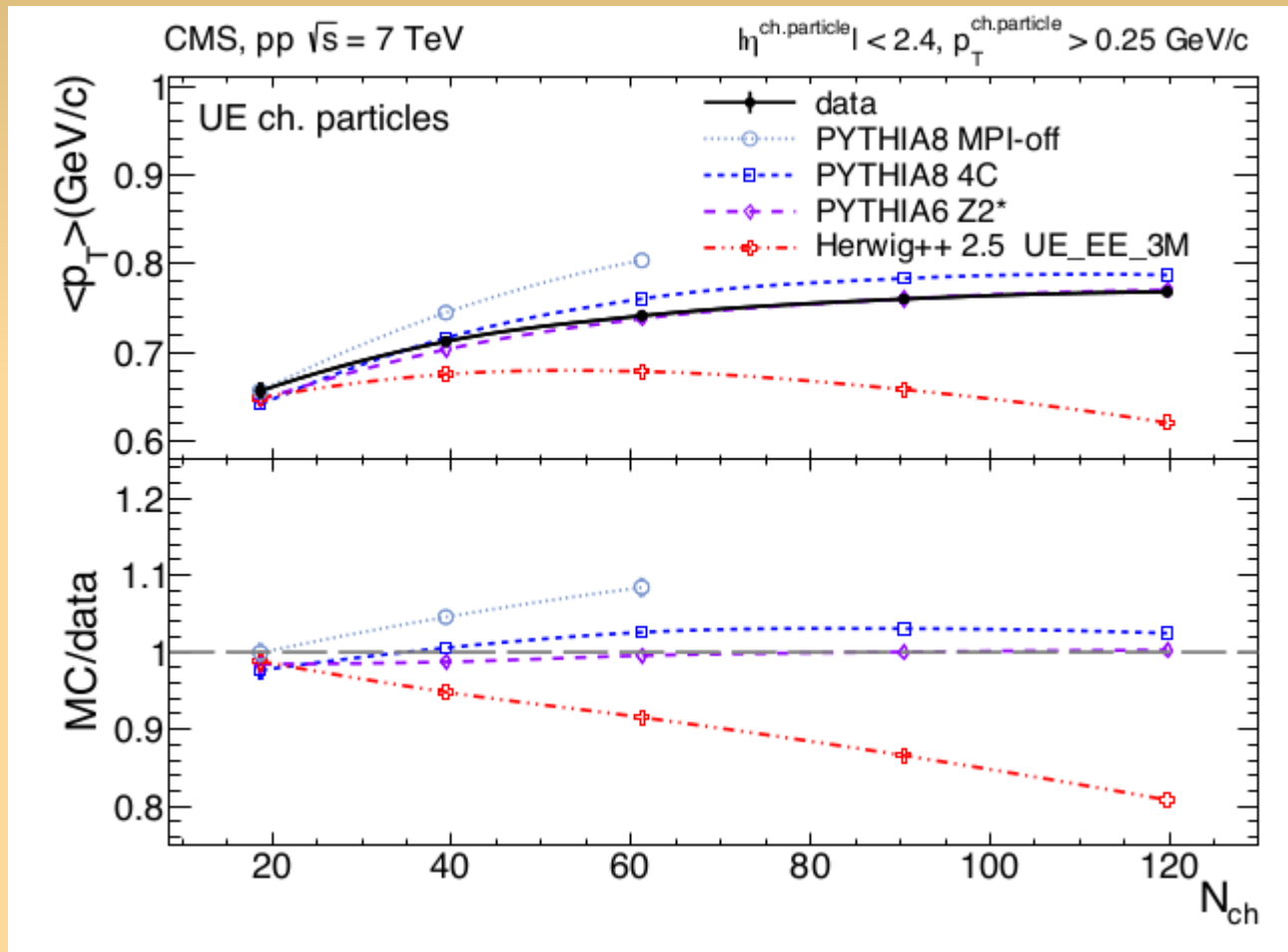


[CMS-TOP-13-007]

New in 2013

- UE properties as a function of charged-particle multiplicity in pp collisions at 7 TeV (Maxim's talk).
- Classifying particles to intrajet and UE.
- Charged particles, $p_T > 0.25$ GeV/c and $|\eta| < 2.4$
  - 5 regions from $10 < N \leq 30$ to $110 < N \leq 140$.

Mean p_T of UE vs Multiplicity



[CMS-FSQ-12-022]

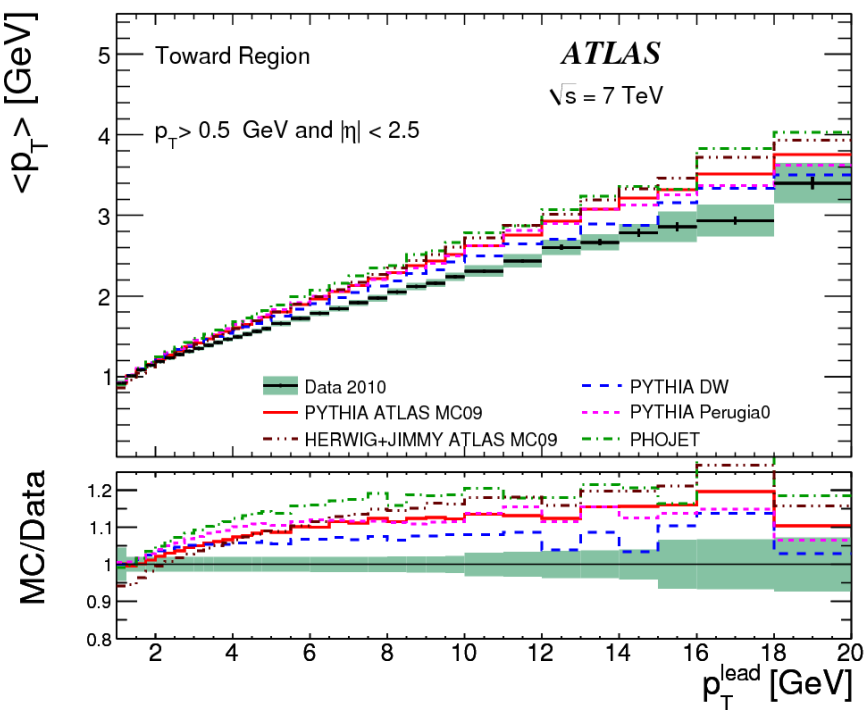
UE in CMS (Bird's-eye view)

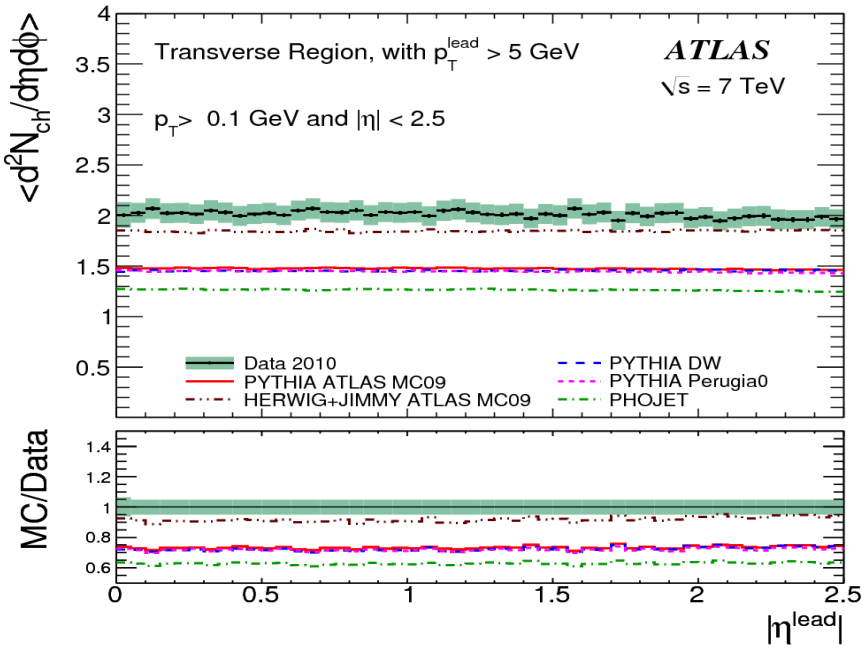
- Different leading objects:

  Jets, tracks, DY, forward jets, tt(bar) and multiplicity.
- Different definitions of UE: Charged, neutral, and strange.
- Median/area.
- Many are done at different COM energies.
- Strong emphasis on team play (ALICE, CDF).
- Coded in RIVET (mostly).
- Tuning studies are underway.

ATLAS

- UE using the leading track:
  - Similar to CMS (different η cut)
  - Other observables.

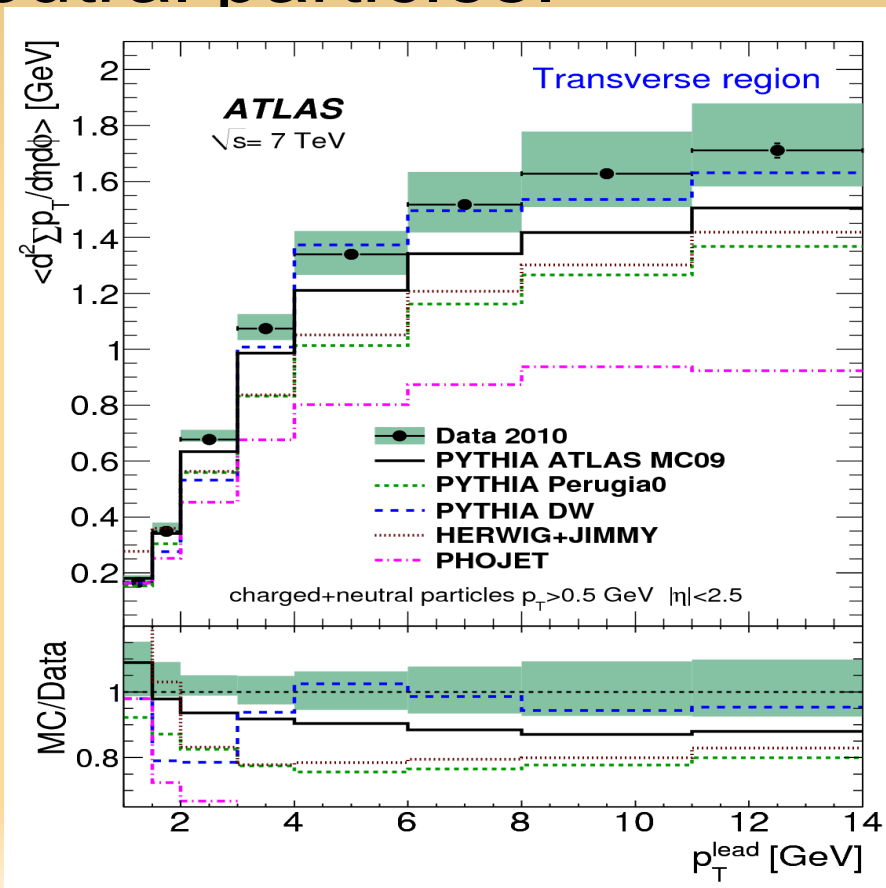


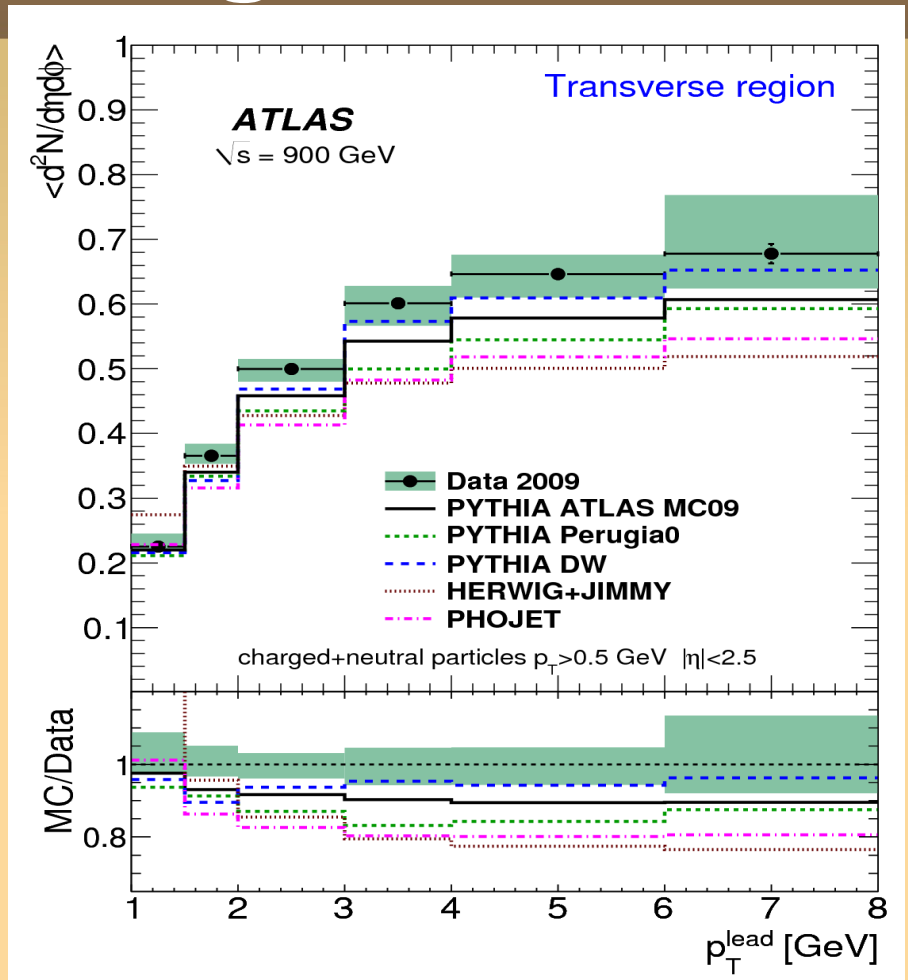


[Phys. Rev. D83 (2011) 112001]

UE Using The Leading Track-2

- This time using the calorimeter to include neutral particles.

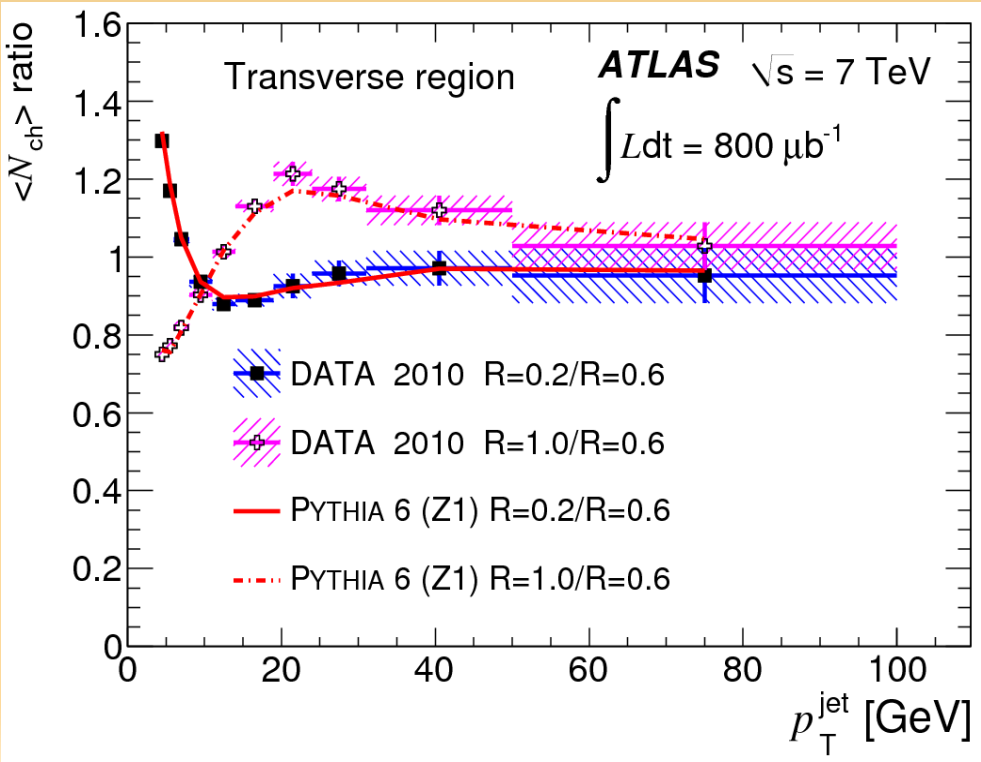


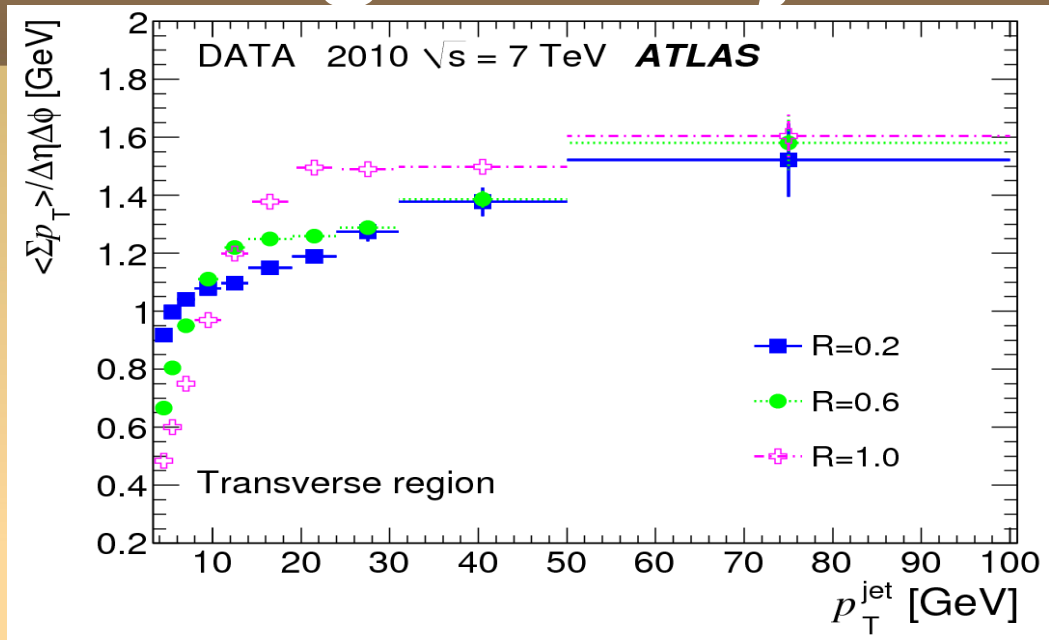


[Eur.Phys.J. C71 (2011) 1636]

UE Using The Leading Track-jet

- The emphasis is on the UE vs jet radius.





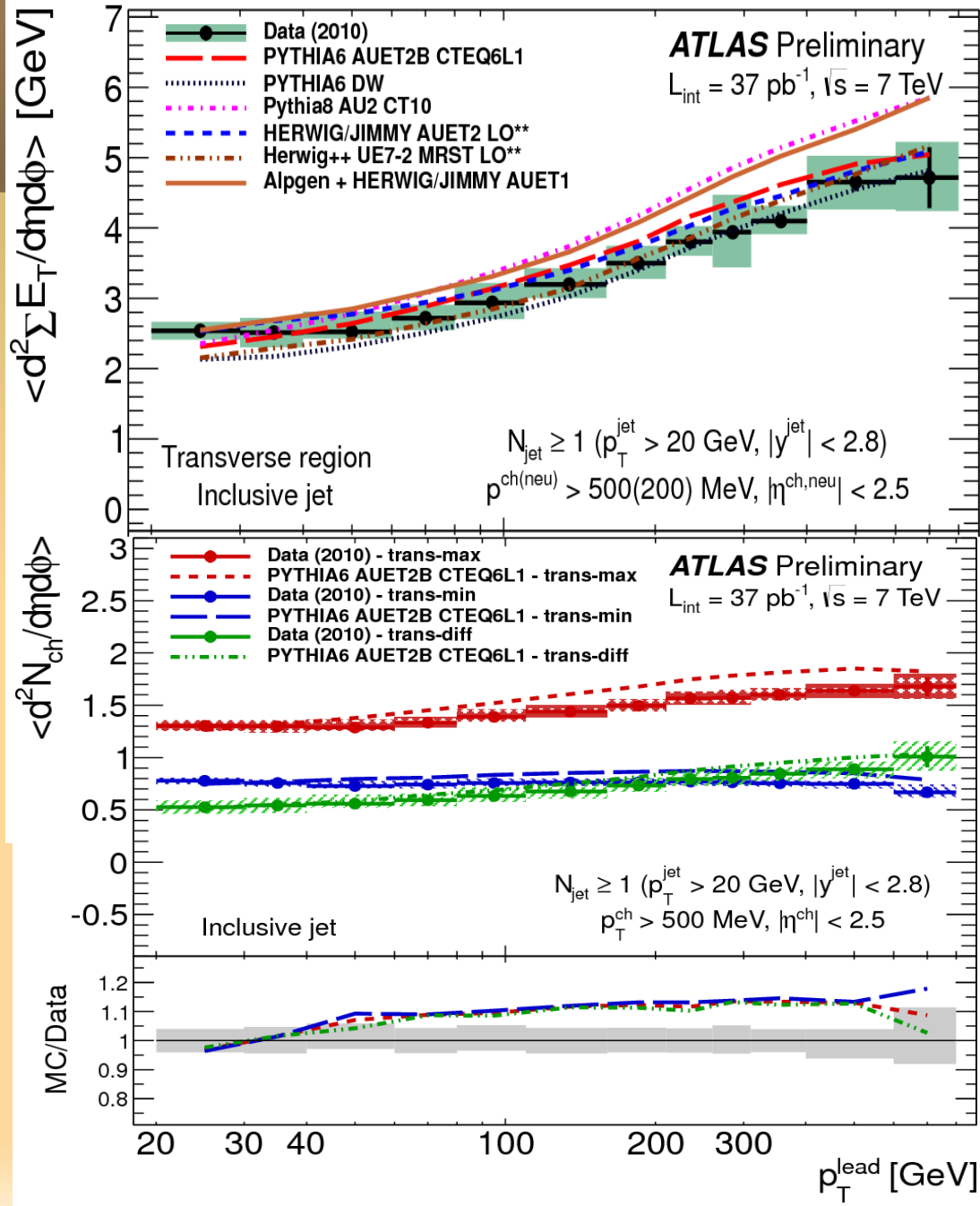
- UE has a moderate dependence on R.
- MC looks to adequately model the dependence on jet radius.

[Phys. Rev. D 86 (2012) 072004]

Max and Min

- Adding Neutral particles to the UE.
- Studying the Max, Min., and Dif regions.
- Inclusive vs. exclusive

[ATLAS-CONF-2012-164]



13.12.02

UE in ATLAS (Bird's-eye view)

- Different leading objects: Jets and tracks.
- Different definitions of UE: Charged and neutral.
- Many more constrains (R, Njet)
- Plenty distributions and observables: ET, and the variance.
- All is coded in RIVET.
- Tuning studies are underway.

Back to our theme

CMS seem to have more blind men, ATLAS' blind men have more fingers.

Conclusions

- The past 5 years witnessed a good commitment from CMS and ATLAS in studying the UE.
- Both collaborations produced excellent results that succeeded in challenging prevailing MC models.
- Different approaches:
  - CMS: Many separate analyses, with few observables delivered in each one.
  - ATLAS: Fewer analyses, each one showing plenty of observables.
- Each team seems “almost” blind to the other team's tunning efforts. True/false? Good/bad?

Thank you

- More details about CMS analyses can be found at: https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsFSQ#Multi_Parton_Interactions_MPI_Un
- More details about ATLAS analyses can be found at:

  https://twiki.cern.ch/twiki/bin/view/AtlasPublic/StandardModelPublicResults#Soft_QCD