Recent Underlying Event studies at the Tevatron

Deepak Kar

IKTP, TU Dresden

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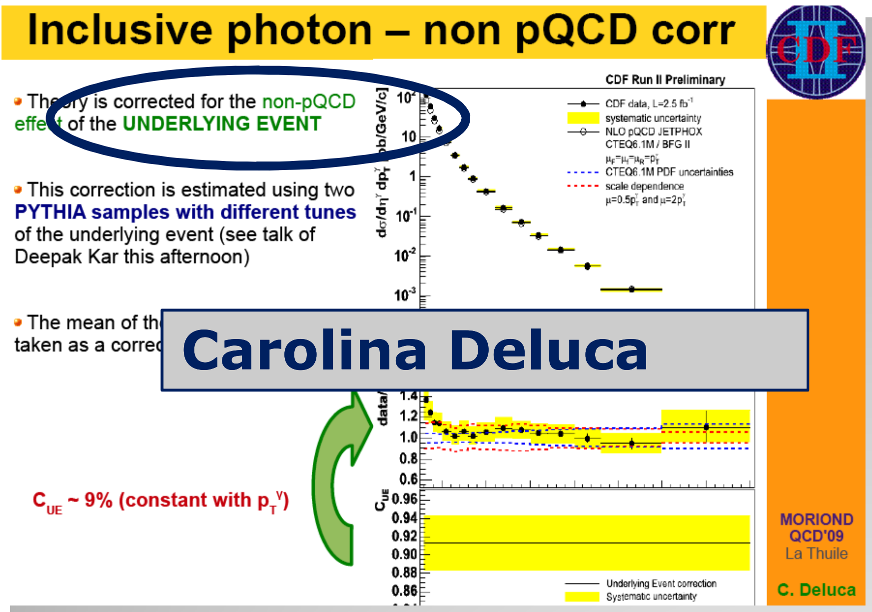
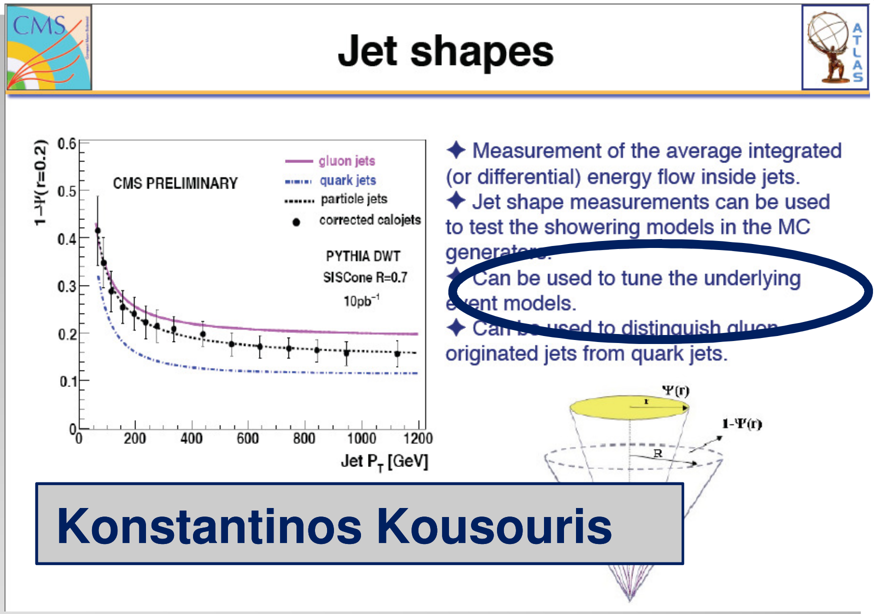


Inclusive photon – non pQCD corr

- Theory is corrected for the non-pQCD effect of the **UNDERLYING EVENT**
- This correction is estimated using two **PYTHIA samples with different tunes** of the underlying event (see talk of Deepak Kar this afternoon)
- The mean of th… taken as a correc…

C_{UE} ~ 9% (constant with p_T^γ)

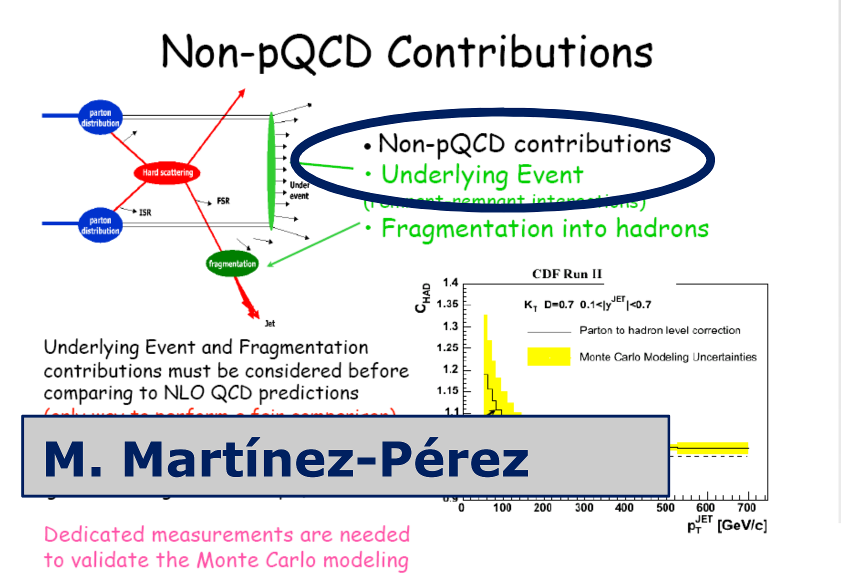
Carolina Deluca



Jet shapes

- ✦ Measurement of the average integrated (or differential) energy flow inside jets.
- ✦ Jet shape measurements can be used to test the showering models in the MC generators.
- ✦ Can be used to tune the underlying event models.
- ✦ Can be used to distinguish gluon originated jets from quark jets.

Konstantinos Kousouris



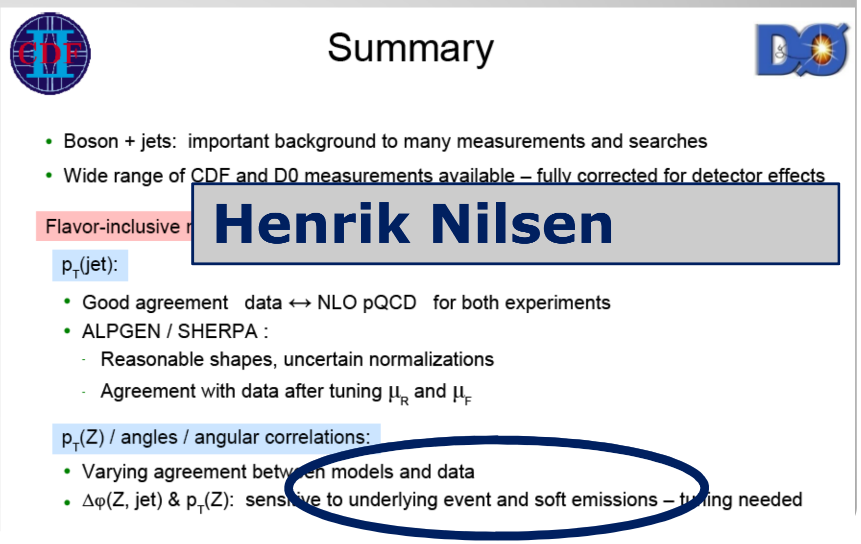
Non-pQCD Contributions

- Non-pQCD contributions
  - Underlying Event (remnant-remnant interactions)
  - Fragmentation into hadrons

Underlying Event and Fragmentation contributions must be considered before comparing to NLO QCD predictions (only way to perform a fair comparison)

Dedicated measurements are needed to validate the Monte Carlo modeling

M. Martínez-Pérez



Summary

- Boson + jets: important background to many measurements and searches
- Wide range of CDF and D0 measurements available – fully corrected for detector effects

Flavor-inclusive r

p_T(jet):

- Good agreement data ↔ NLO pQCD for both experiments
- ALPGEN / SHERPA :
  - Reasonable shapes, uncertain normalizations
  - Agreement with data after tuning μ_R and μ_F

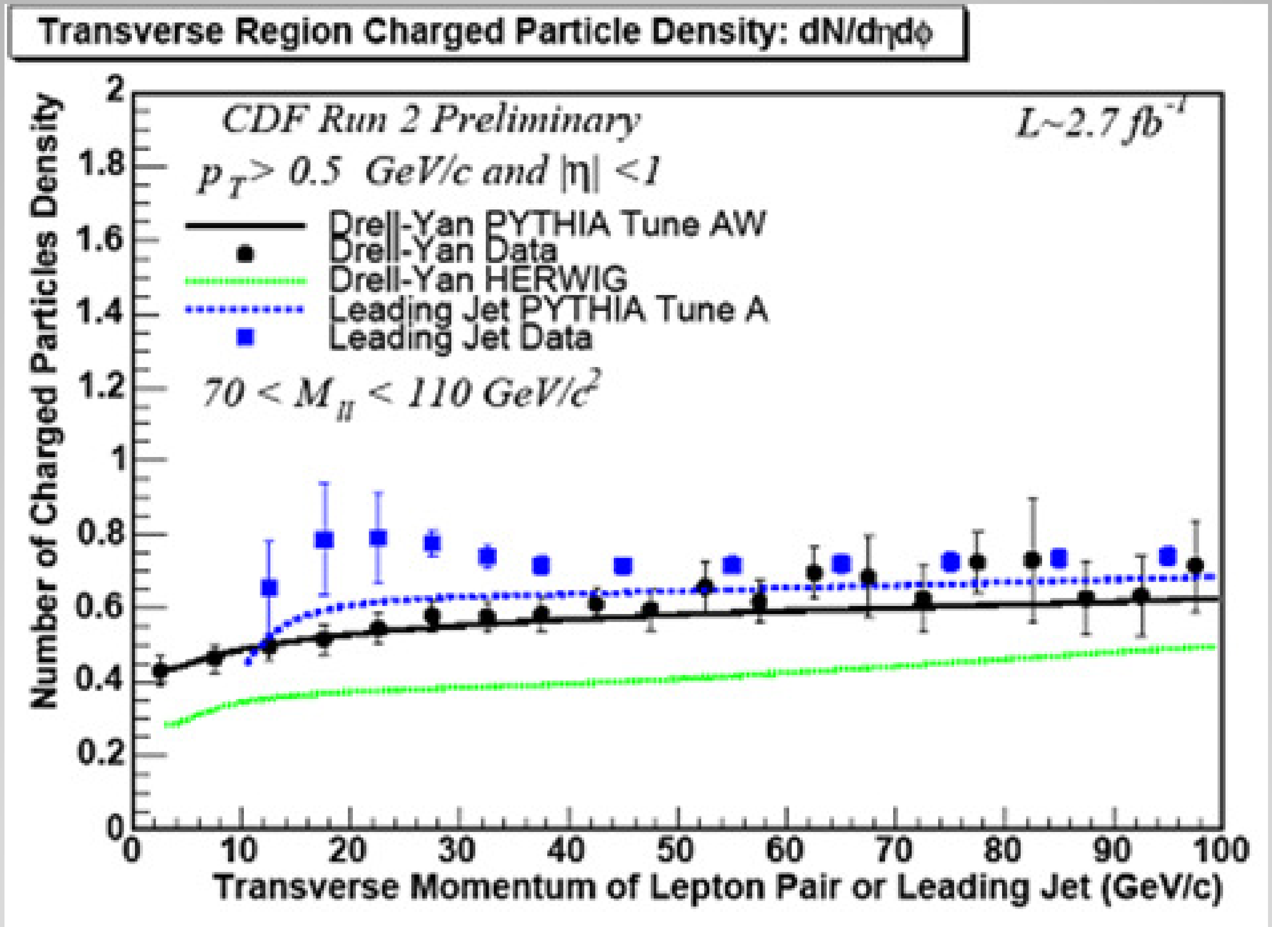
p_T(Z) / angles / angular correlations:

- Varying agreement between models and data
- $\Delta\varphi$(Z, jet) & p_T(Z): sensitive to underlying event and soft emissions – tuning needed

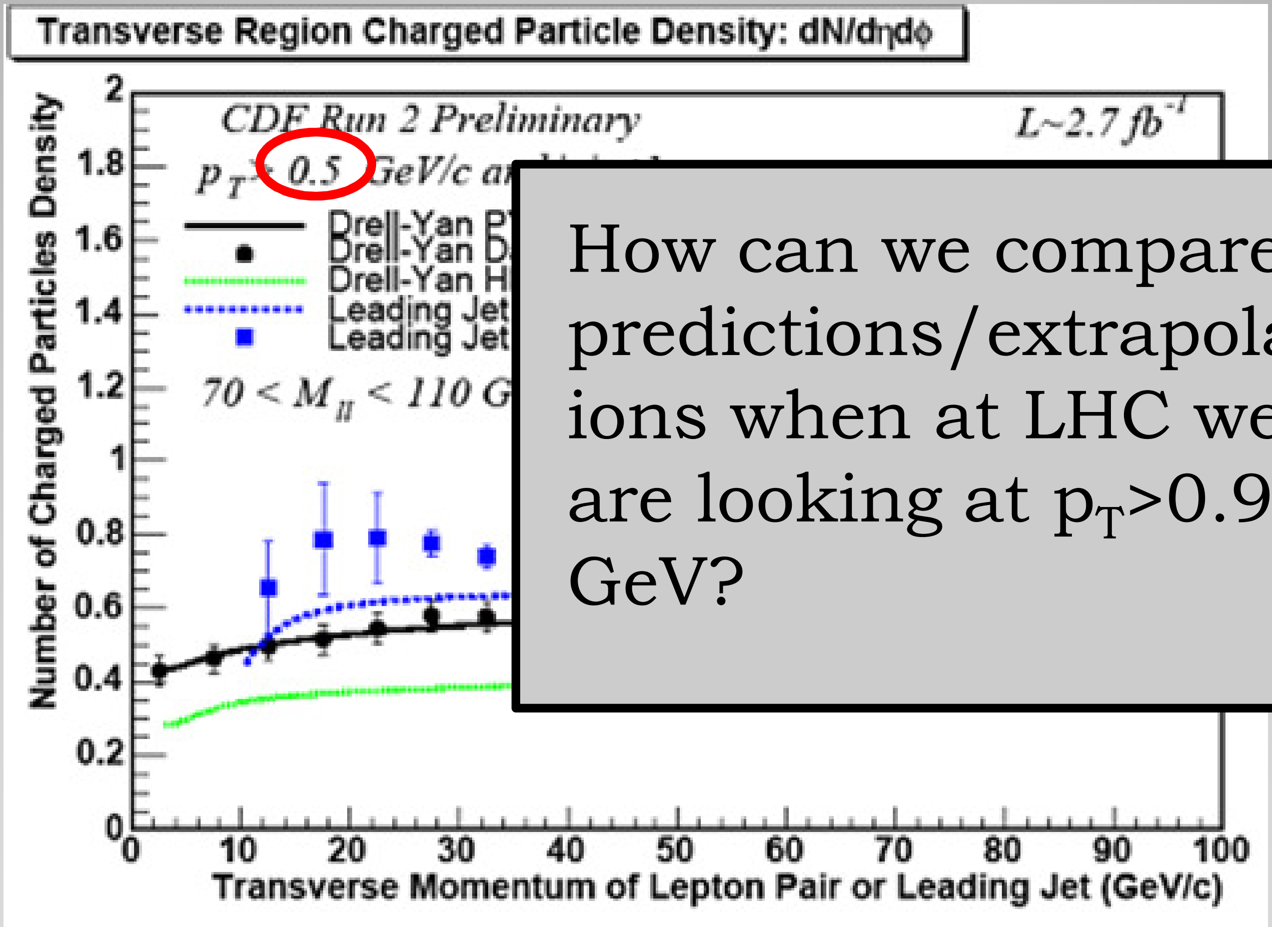
Henrik Nilsen

Results (I):
The underlying event observables as a function of the lepton pair p_T

Charged Particle Multiplicity

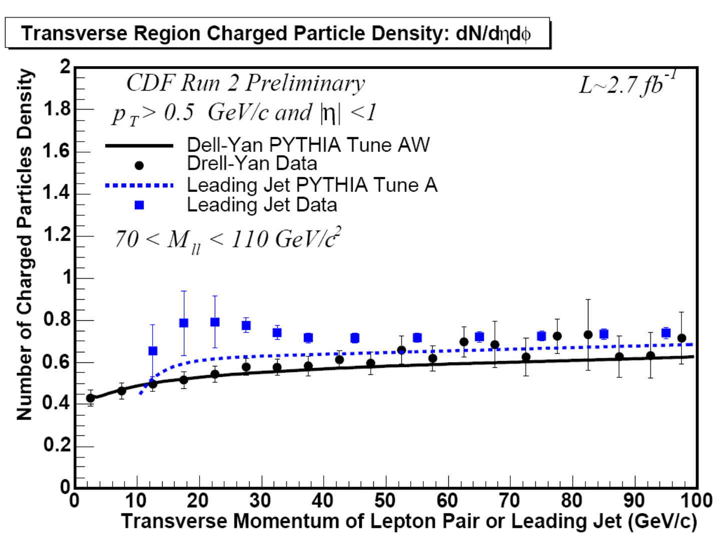


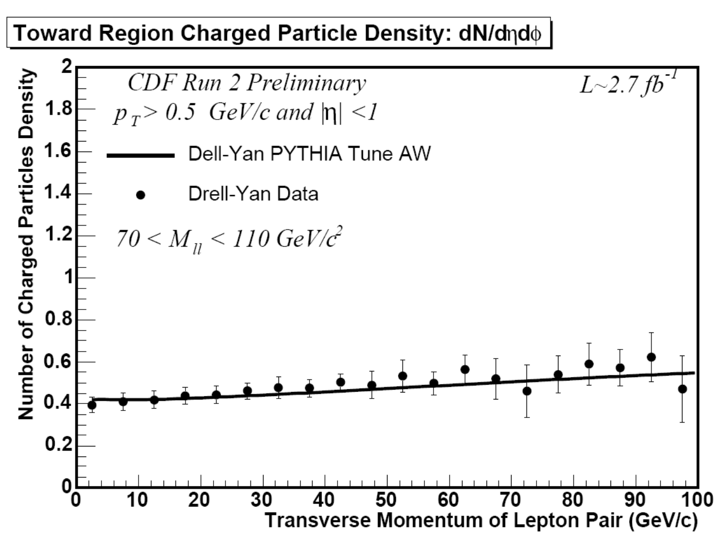
Charged Particle Multiplicity

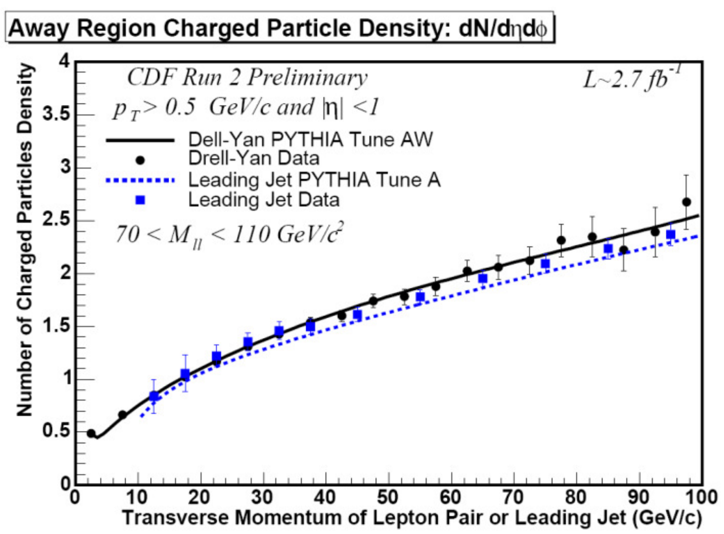


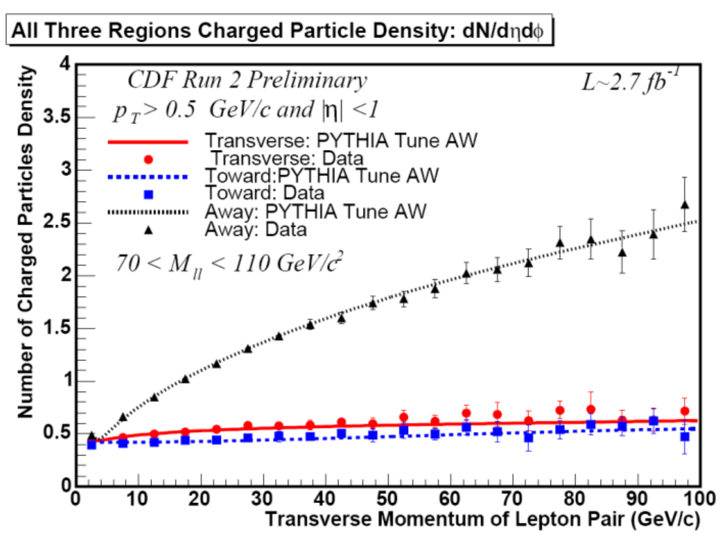
How can we compare predictions/extrapolations when at LHC we are looking at p_T>0.9 GeV?

Charged Particle Multiplicity (I)

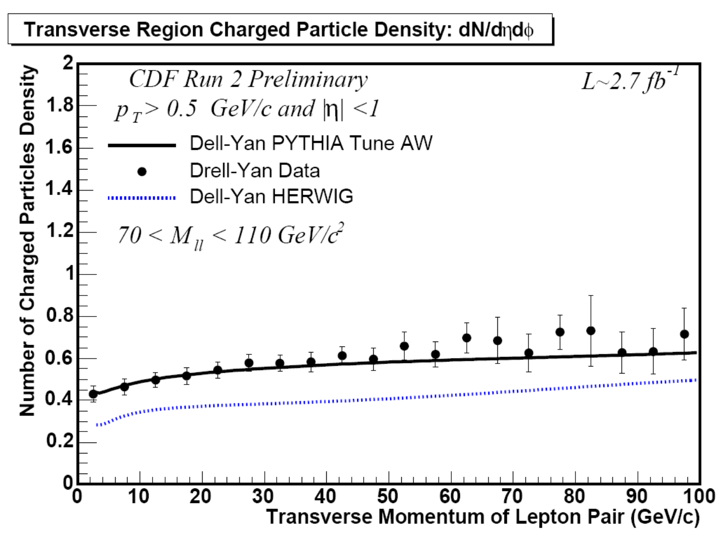

Transverse Region Charged Particle Density: dN/dηdφ

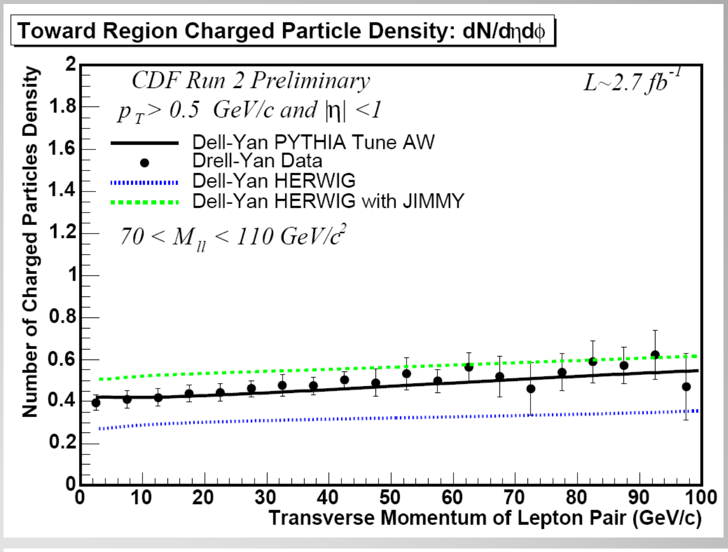

Toward Region Charged Particle Density: dN/dηdφ

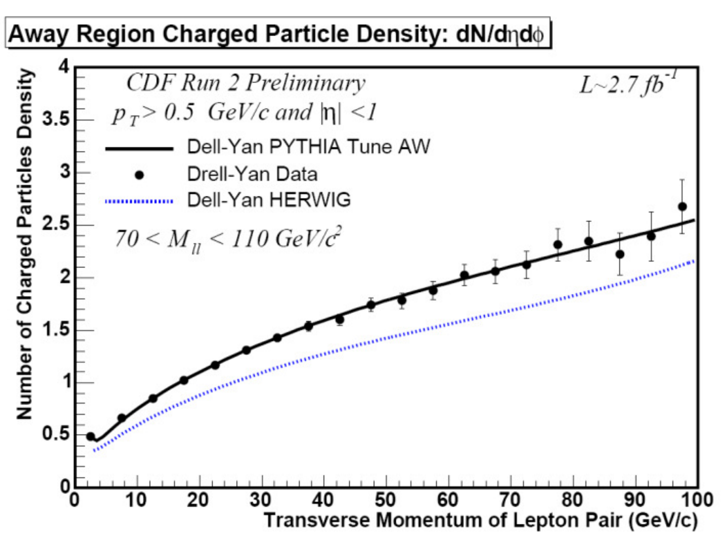

Away Region Charged Particle Density: dN/dηdφ

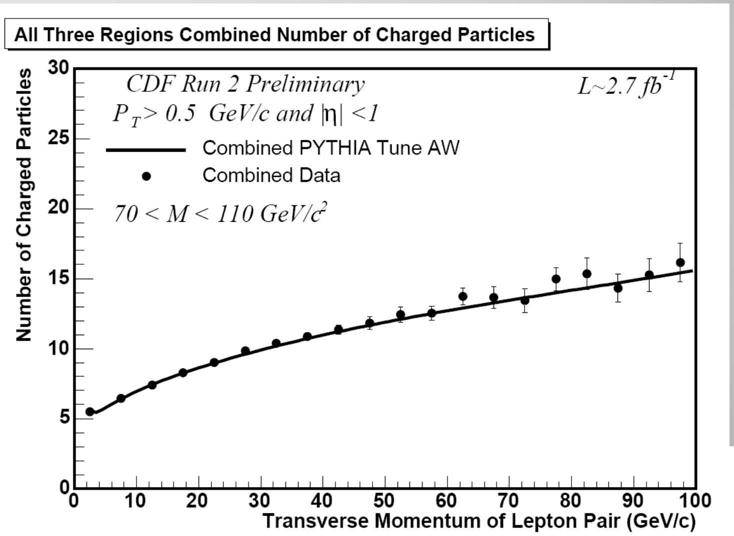

All Three Regions Charged Particle Density: dN/dηdφ

Charged Particle Multiplicity (II)

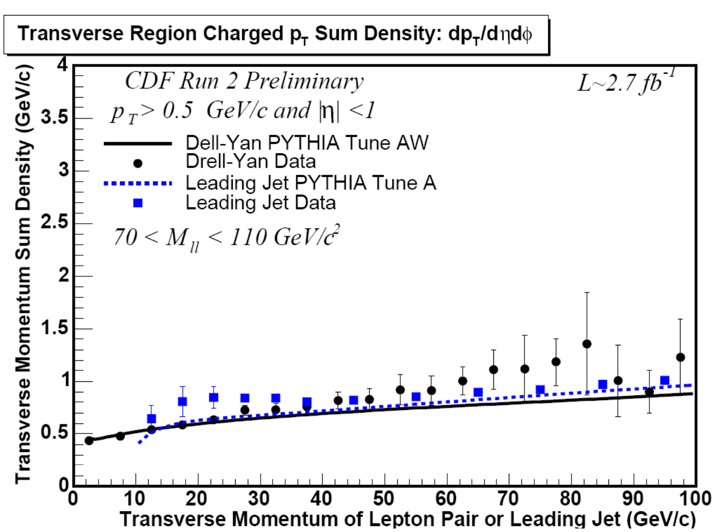


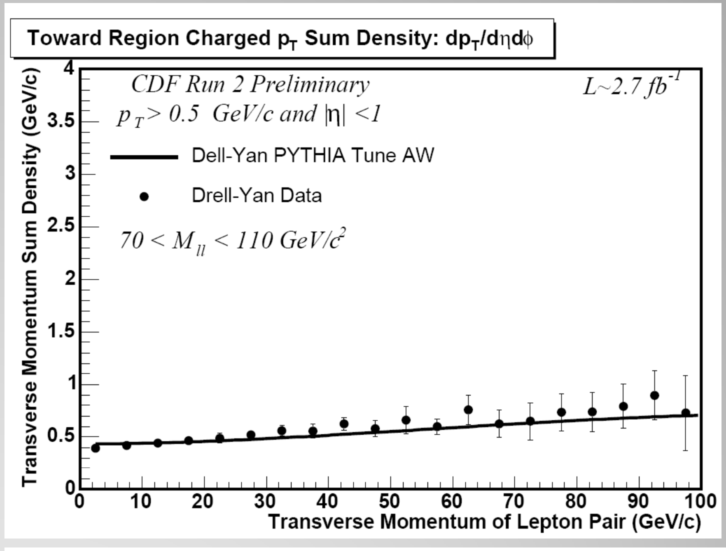


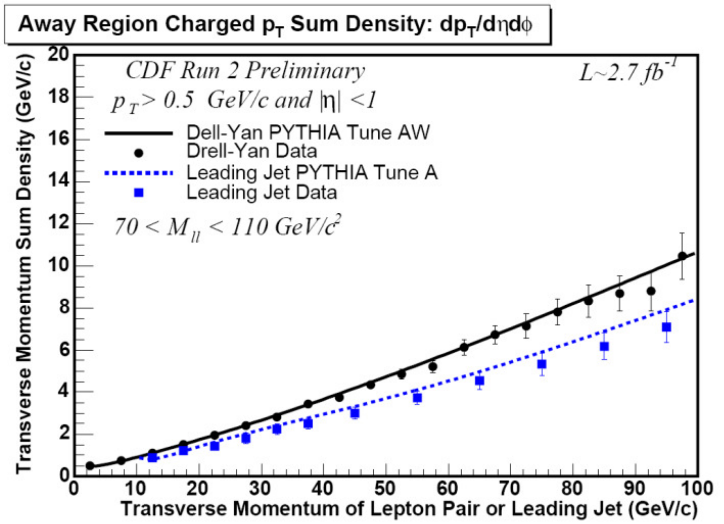


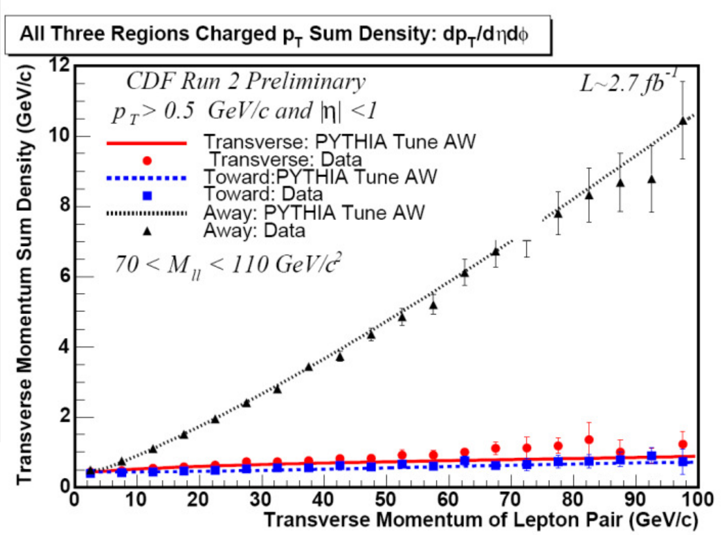


Charged Transverse Momentum Sum (I)

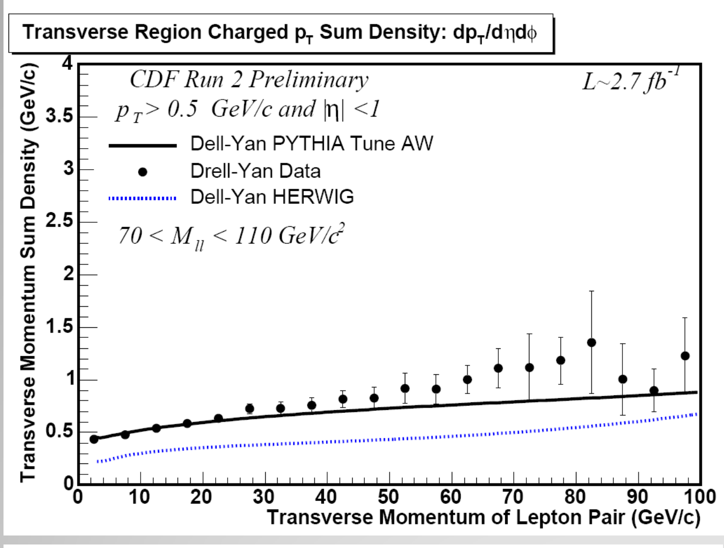

Transverse Region Charged p_T Sum Density: $dp_T/d\eta d\phi$

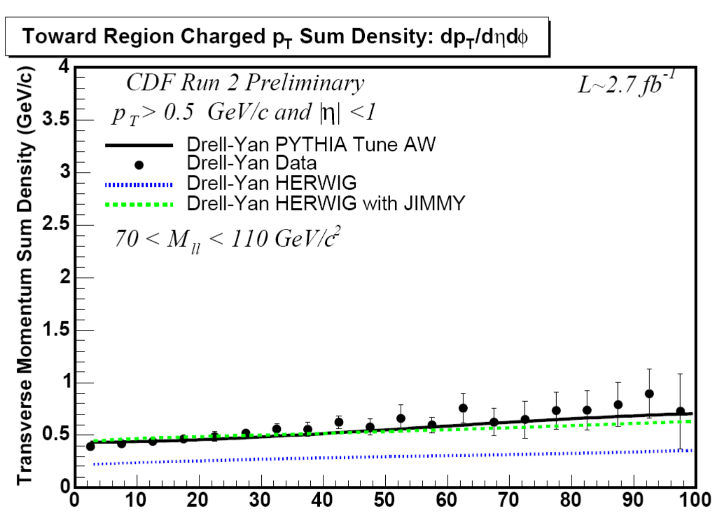

Toward Region Charged p_T Sum Density: $dp_T/d\eta d\phi$

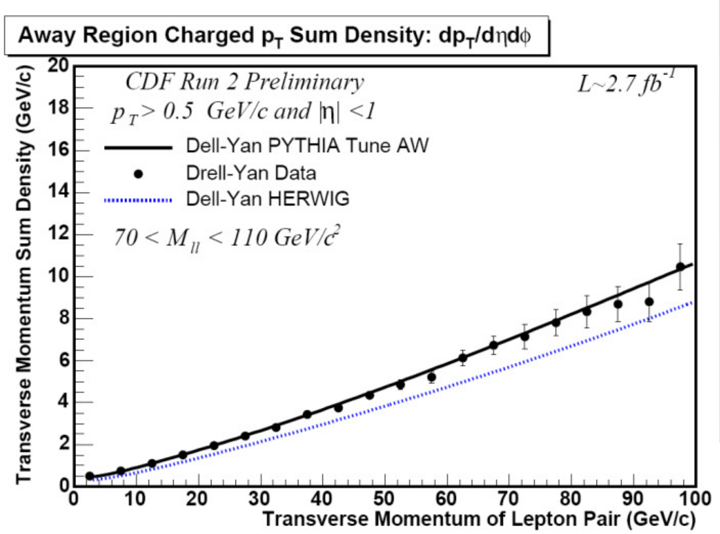

Away Region Charged p_T Sum Density: $dp_T/d\eta d\phi$

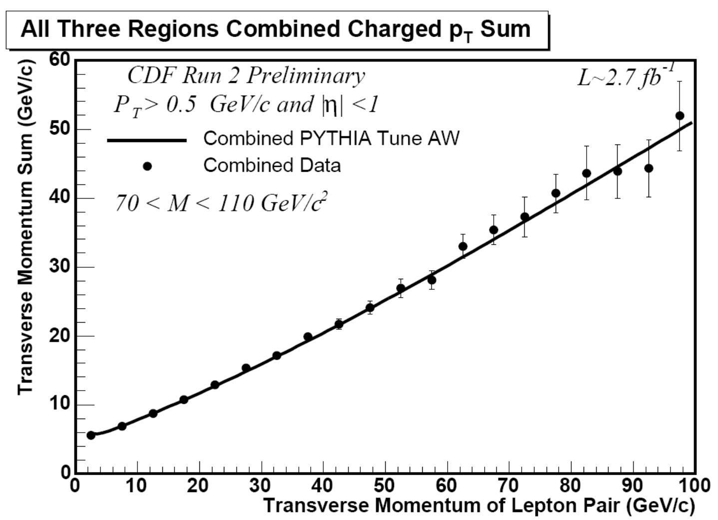

All Three Regions Charged p_T Sum Density: $dp_T/d\eta d\phi$

Charged Transverse Momentum Sum (II)

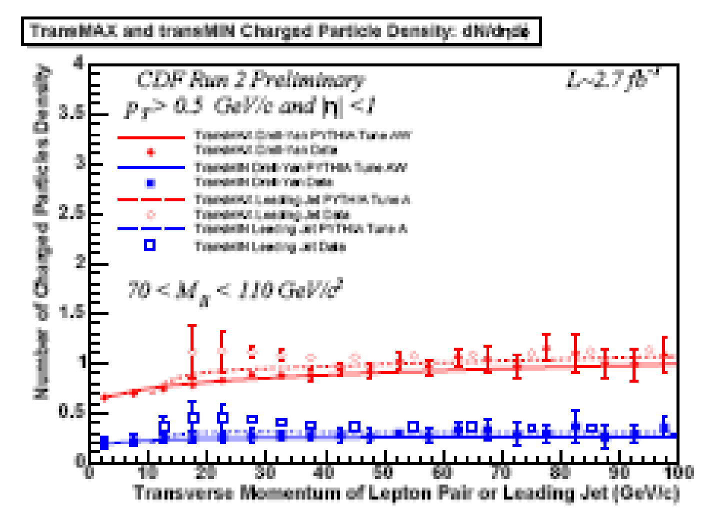

Transverse Region Charged p_T Sum Density: $dp_T/d\eta d\phi$

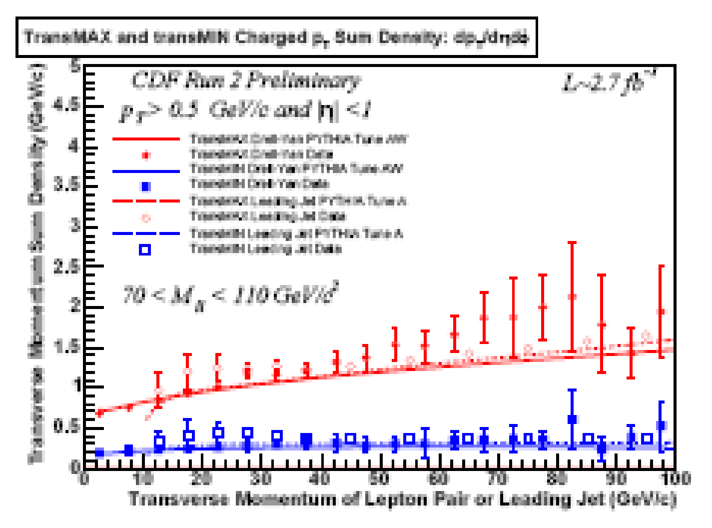

Toward Region Charged p_T Sum Density: $dp_T/d\eta d\phi$

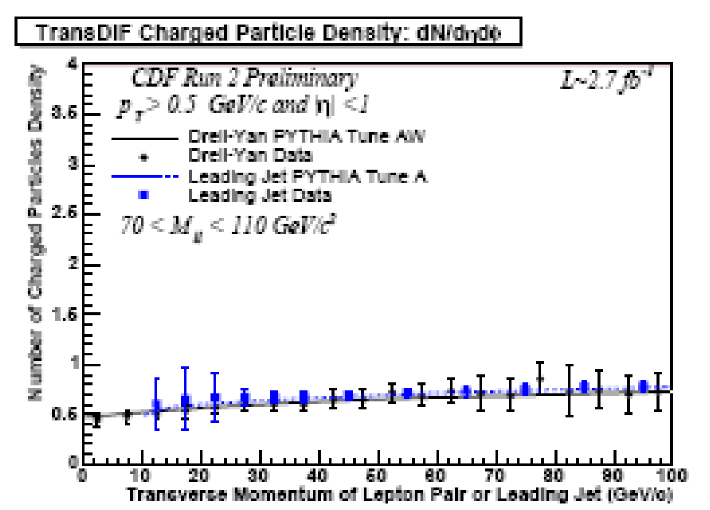

Away Region Charged p_T Sum Density: $dp_T/d\eta d\phi$

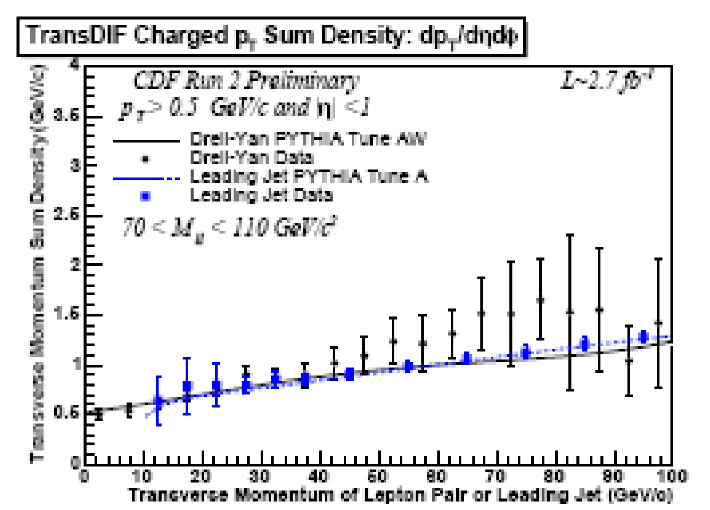

All Three Regions Combined Charged p_T Sum

TransMAX, MIN, DIF Regions

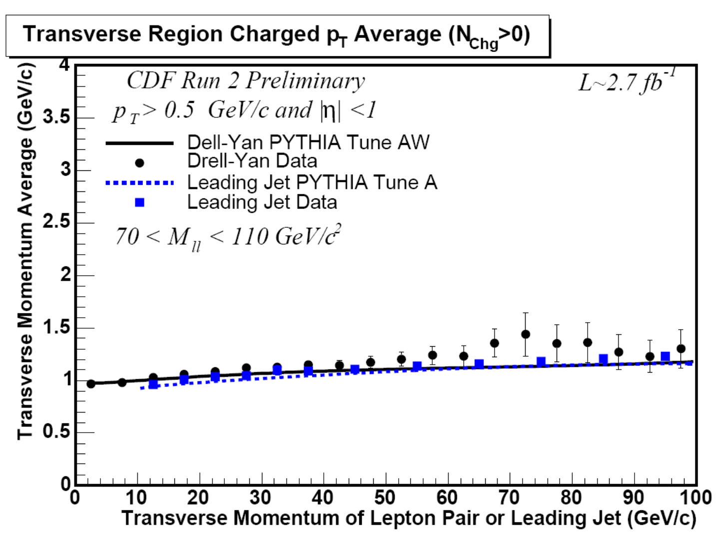

TransMAX and transMIN Charged Particle Density: dN/dηdφ

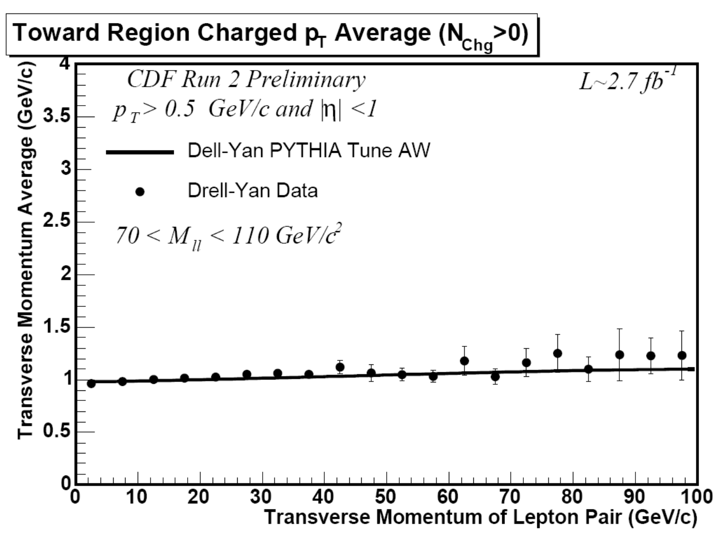

TransMAX and transMIN Charged p_T Sum Density: $dp_T/d\eta d\phi$

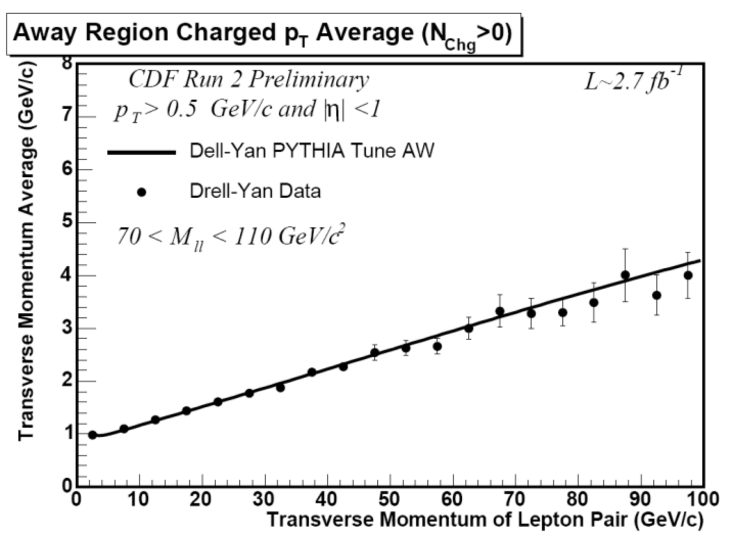

TransDIF Charged Particle Density: dN/dηdφ

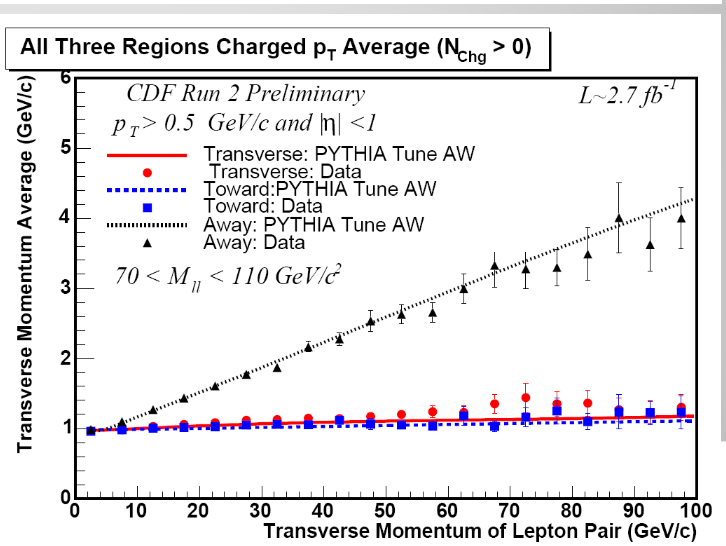

TransDIF Charged p_T Sum Density: $dp_T/d\eta d\phi$

Charged Transverse Momentum Average

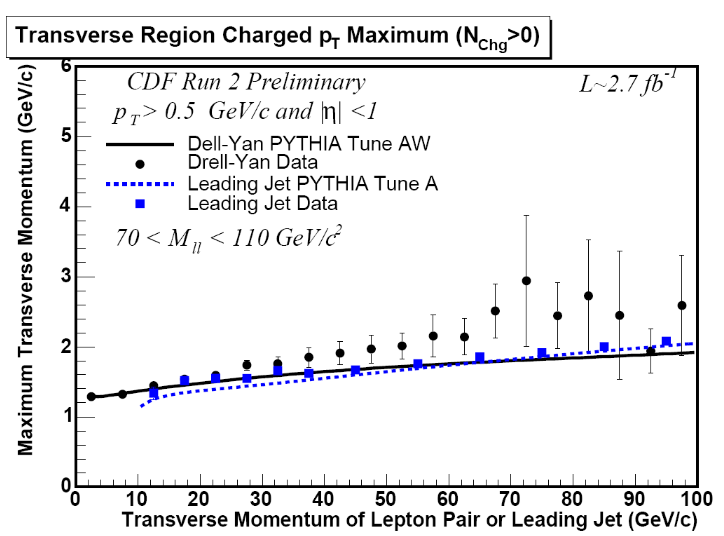

Transverse Region Charged p_T Average (N_{Chg}>0)


Toward Region Charged p_T Average (N_{Chg}>0)

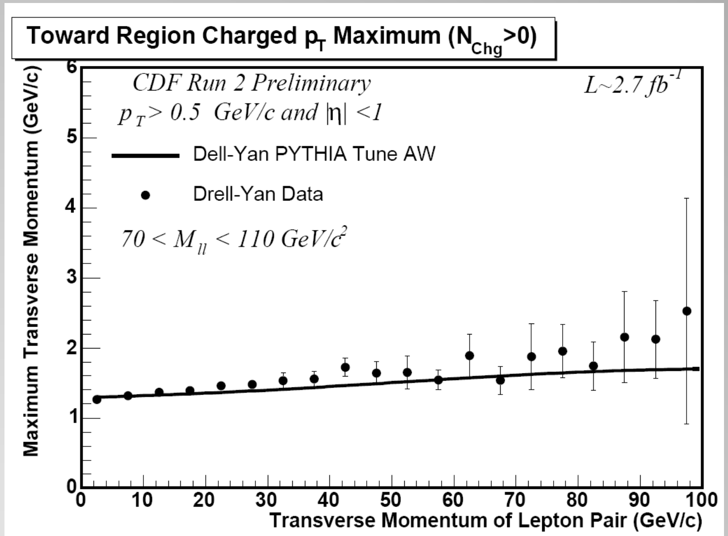

Away Region Charged p_T Average (N_{Chg}>0)


All Three Regions Charged p_T Average (N_{Chg} > 0)

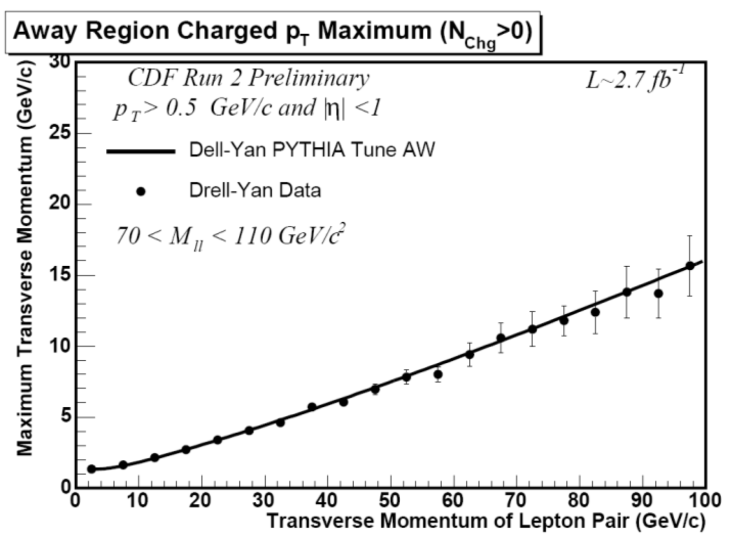
Charged Transverse Momentum Maximum



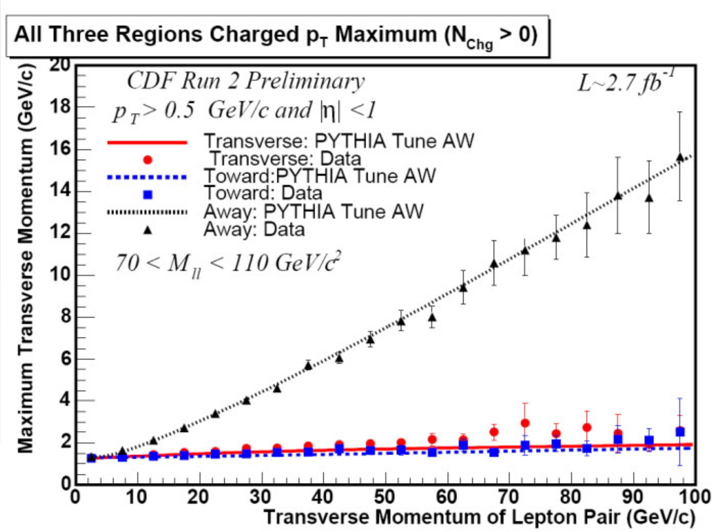
Transverse Region Charged p_T Maximum (N_{Chg}>0)



Toward Region Charged p_T Maximum (N_{Chg}>0)



Away Region Charged p_T Maximum (N_{Chg}>0)



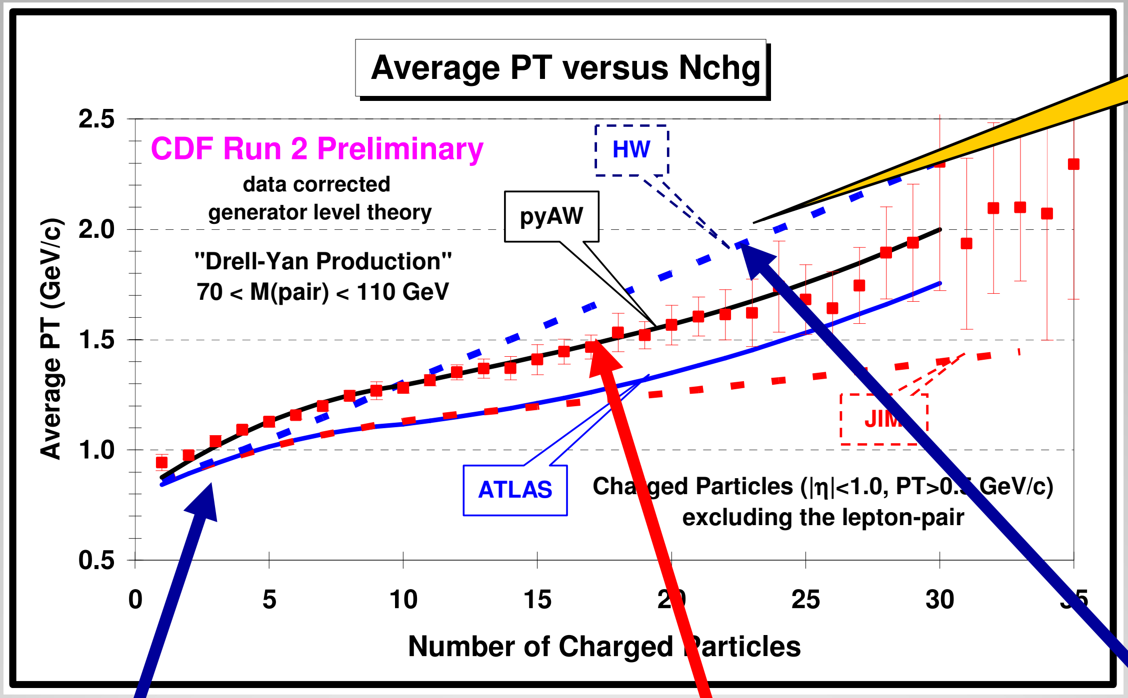
All Three Regions Charged p_T Maximum (N_{Chg} > 0)

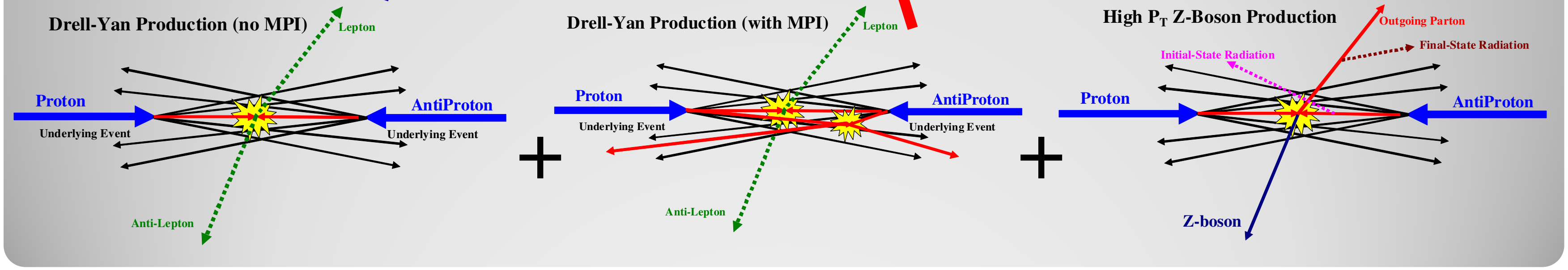
Results (II): Correlation between mean p_T of the charged particles against the charged particle multiplicity

$<p_T>$ versus N_{chg} is a measure of the amount of **hard versus soft** processes contributing and it is **sensitive** to the modeling of the multiple-parton interactions.

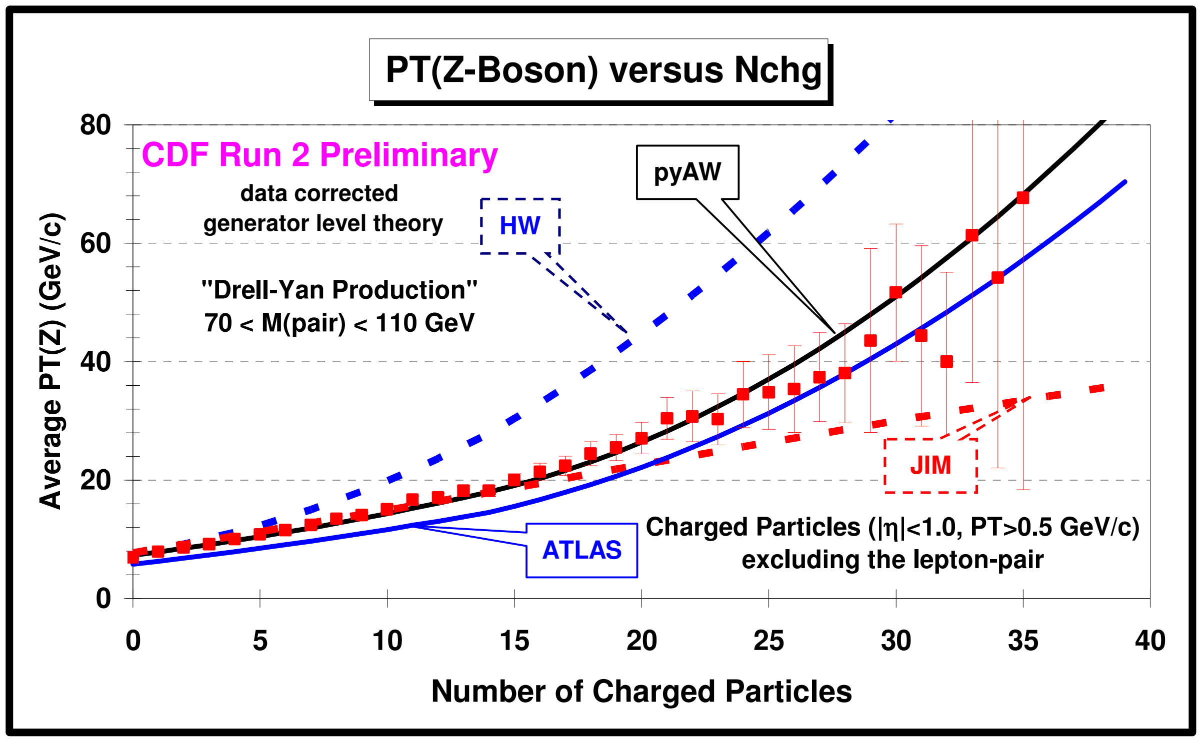
Mean p_T vs Charged Multiplicity

No MPI





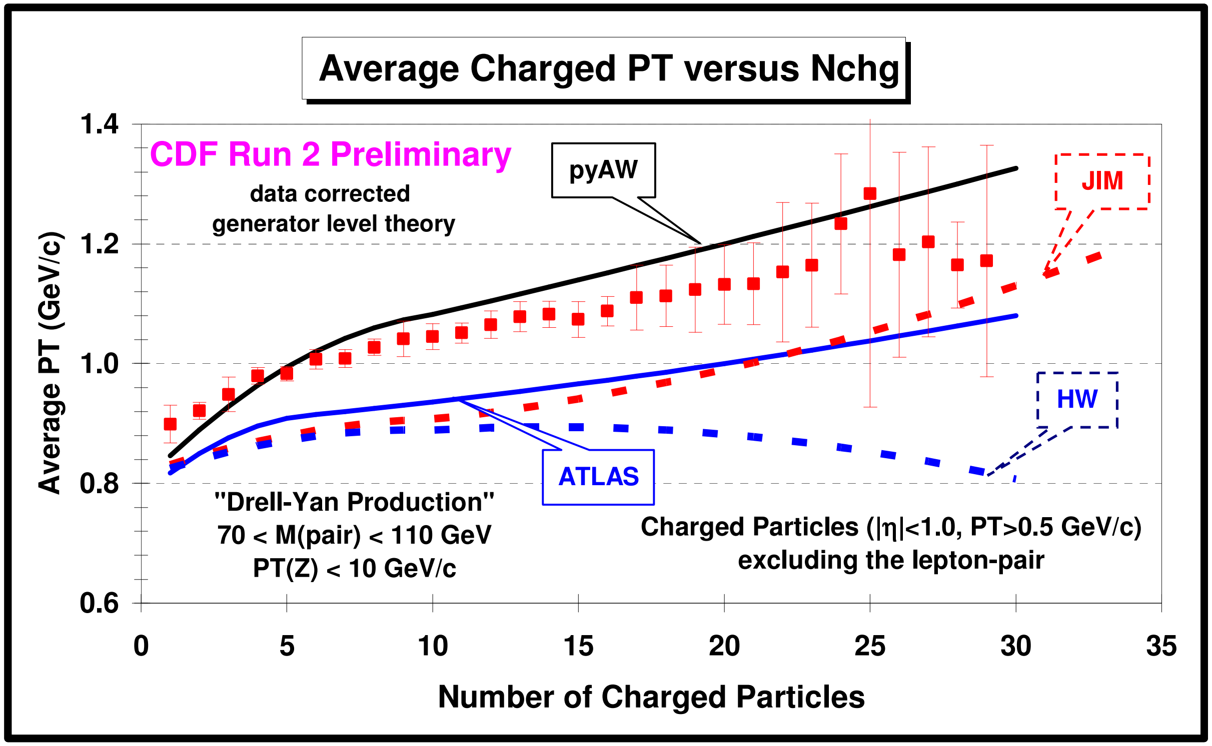
Mean p_T vs Charged Multiplicity



Large N_{chg} implies high p_T jets (i.e. hard 2→2 scattering). Without MPI the only way to get large N_{chg} is to have a very hard 2→2 scattering.

Mean p_T vs Charged Multiplicity

$P_T(Z) < 10$ GeV/c



Multiple-parton interactions provides another mechanism for producing large multiplicities that are harder than the beam-beam remnants, but not as hard as the primary Z +jet hard scattering.

Summary

- Observed excellent agreement with PYTHIA tune AW predictions.
- Close match with leading jet underlying event results –underlying event models (BBR part) independent of hard scattering event?
- By looking at the correlation between $<p_T>$ and charged multiplicity, we can discriminate between different contributing subprocesses.

Outlook

Outlook

- … that's is what LHC is going to be! Potential for analysis with early data!
- Experiences from Tevatron would be invaluable.
- Correct data back to particle level? Essential if we shift toward automated tuning.