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Describing p_T Distributions of Charged Particles in the Underlying Event

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Outline:

- p_T distributions of particles in the UE
- Comparing UE tunings
- Parton showers in PYTHIA – PARP(67)
- Azimuthal decorrelation in di-jet systems
- Conclusions

p_T distribution: particles from the underlying event

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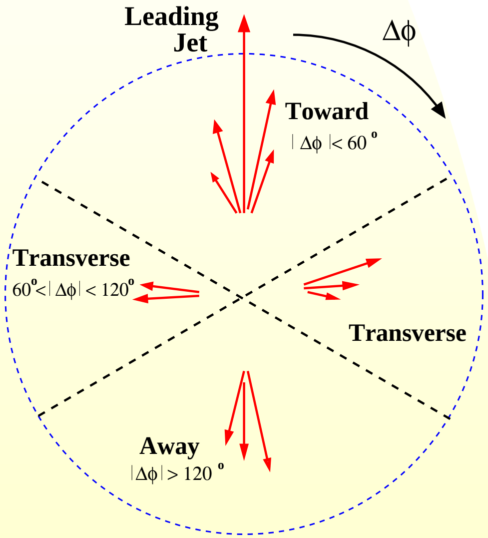
CDF analysis (run I):

- charged particles:

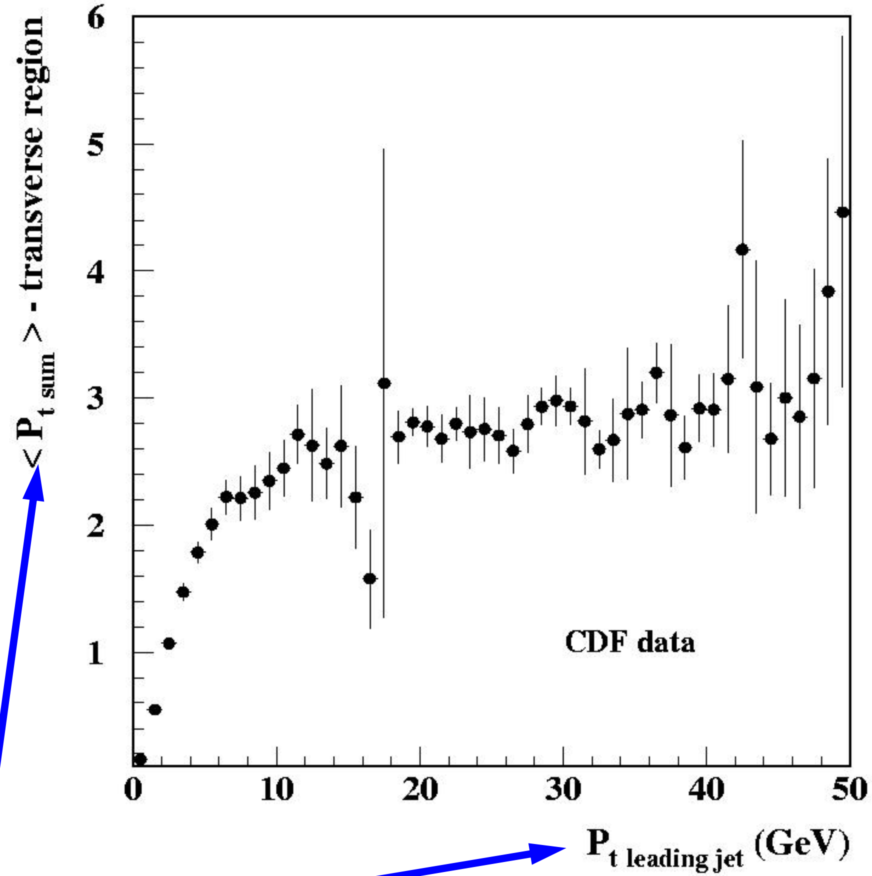
p_t>0.5 GeV and $|\eta|$<1

- **cone jet finder:**

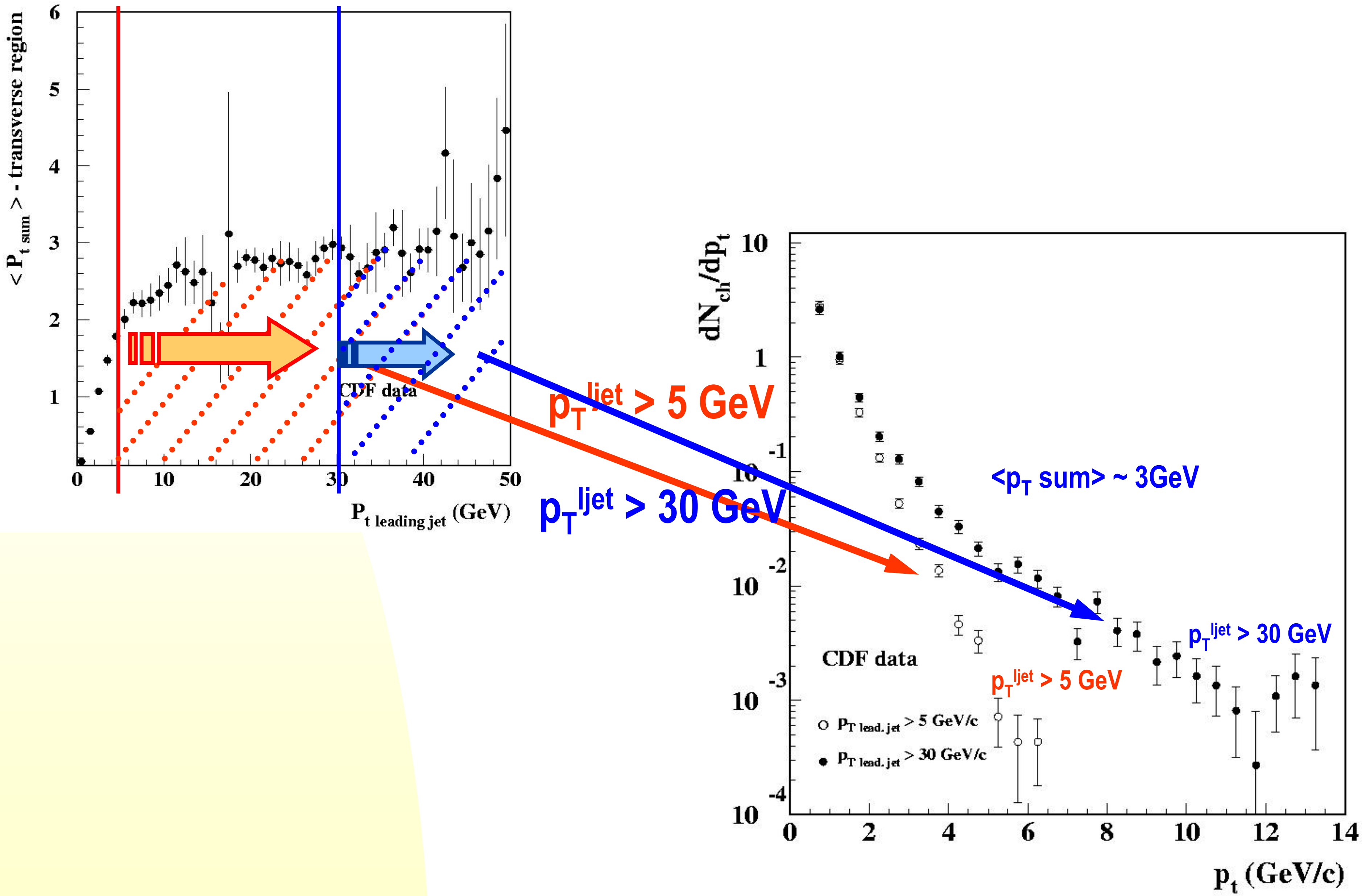
$$R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2} = 0.7$$



$$\Delta\phi = \phi - \phi_{ljet}$$

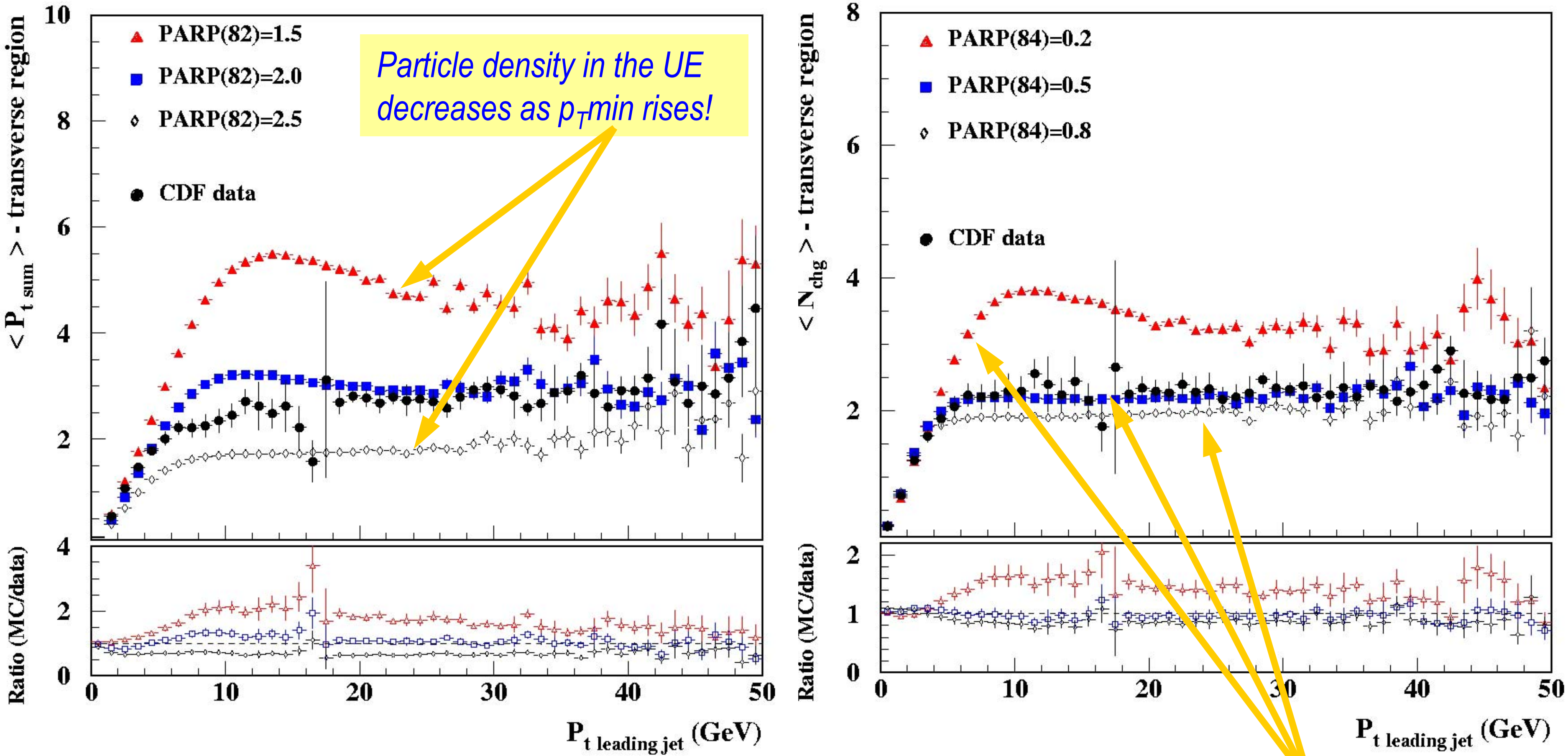


Average p_T^{sum} (GeV) of charged particles in the underlying event associated to a leading jet with P_t^{ljet} (GeV).



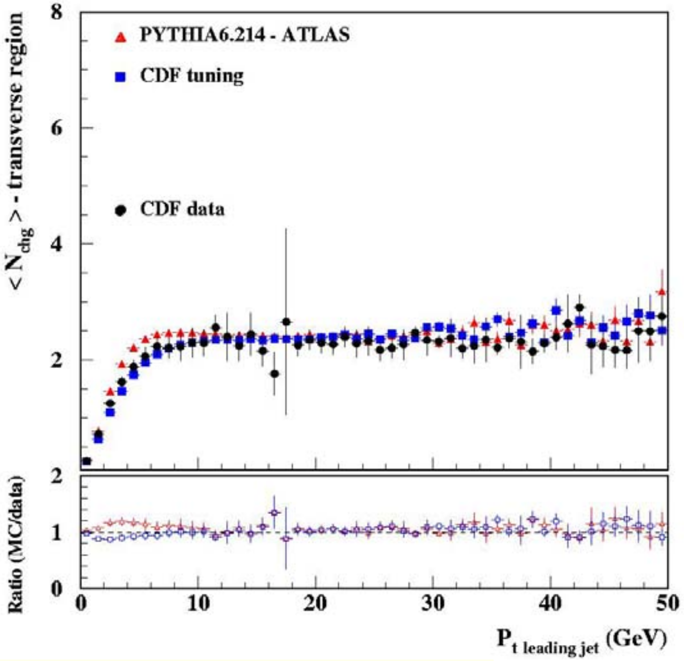
< P_t sum > - transverse region
P_t leading jet (GeV)
CDF data
p_T^ljet > 5 GeV
p_T^ljet > 30 GeV
dN_ch/dp_t
p_t (GeV/c)
<p_T sum> ~ 3GeV
CDF data
P_T lead. jet > 5 GeV/c
P_T lead. jet > 30 GeV/c
p_T^ljet > 30 GeV
p_T^ljet > 5 GeV

Describing the UE with MC event generators (review…)



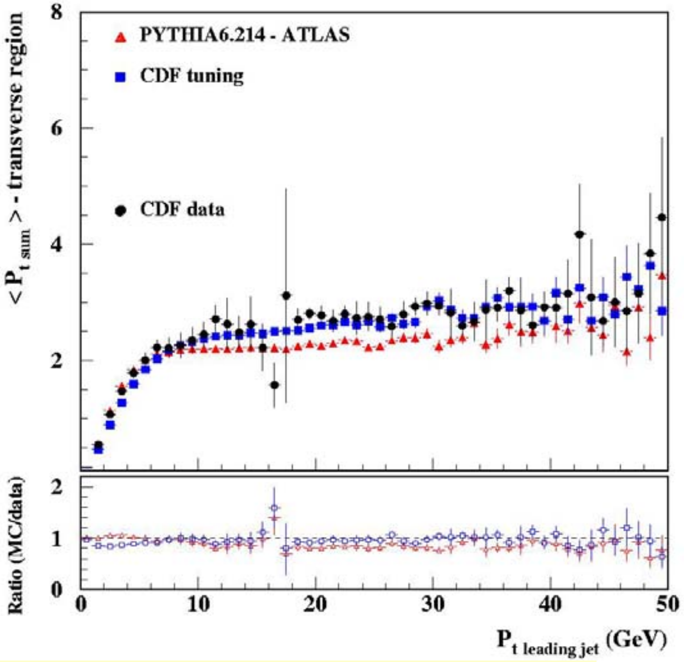
Similarly to the observed for min-bias distributions, varying the lower p_T cut-off also changes the particle density (and p_T density) in the UE.

Small, dense core-size generates more multiplicity in the UE.



PYTHIA – ATLAS
PARP(67) = 1

CTEQ5L
MSTP(82) = 4
PARP(82) = 1.8 PARP(89) = 1 TeV PARP(90) = 0.16
PARP(84) = 0.5
PARP(67) = 1

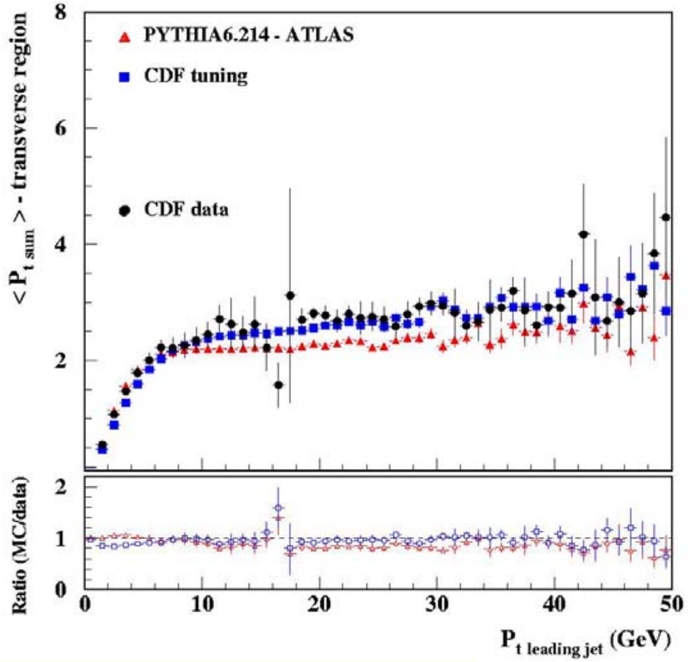


PYTHIA – CDF tune A
PARP(67) = 4

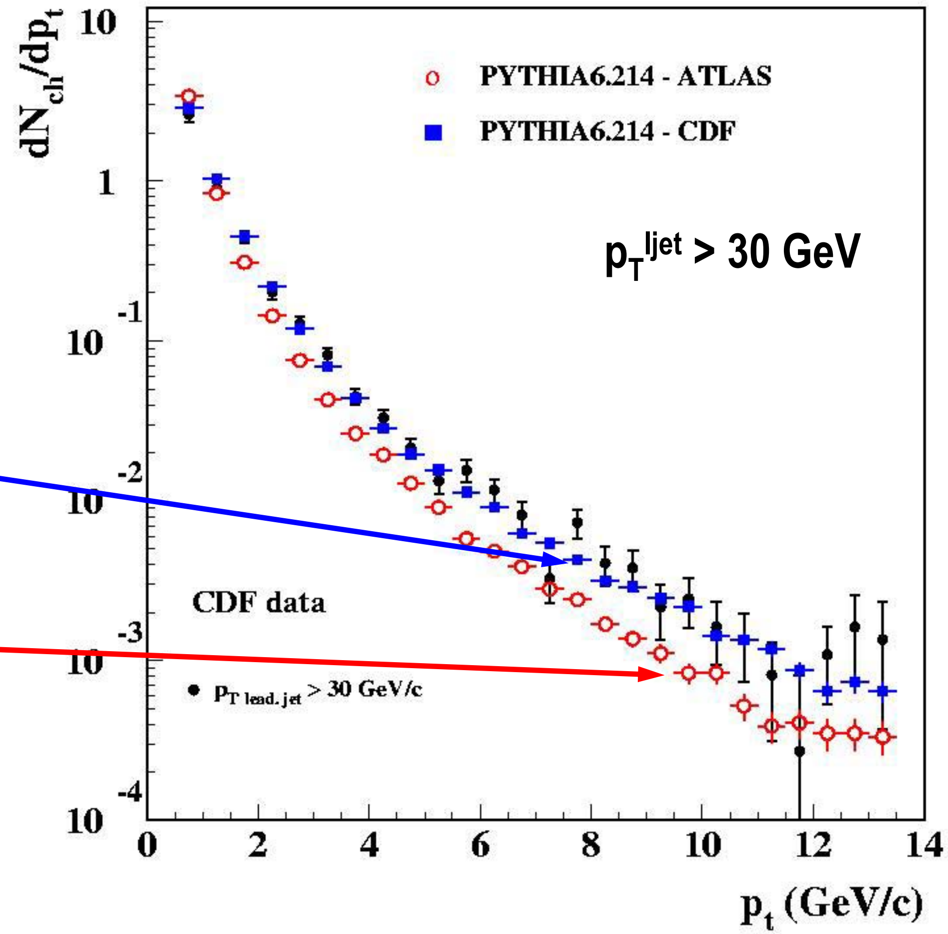
CTEQ5L
MSTP(82) = 4
PARP(82) = 2.0 PARP(89) = 1.8 TeV PARP(90) = 0.25
PARP(84) = 0.4
PARP(67) = 4

Note:

- **both tunings have similar $p_T$min at Tevatron energies** (~2 GeV).
- **both tunings have similar matter distributions** (double Gaussian & r = 0.4 or 0.5).
- **PARP(67) values in these two tunings is very different.**



PARP(67): Q^2 scale of the hard scattering is multiplied by PARP(67) to define the maximum parton virtuality allowed in showers



PARP(67)=4

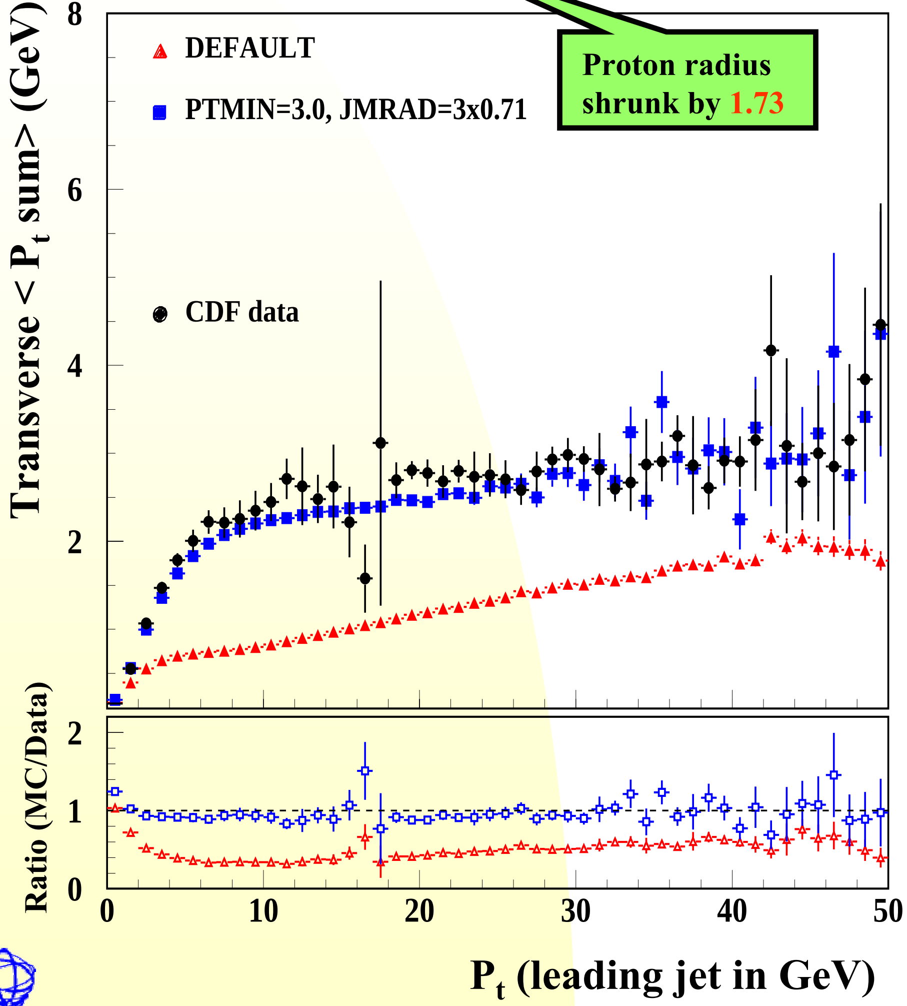
harder p_T spectrum

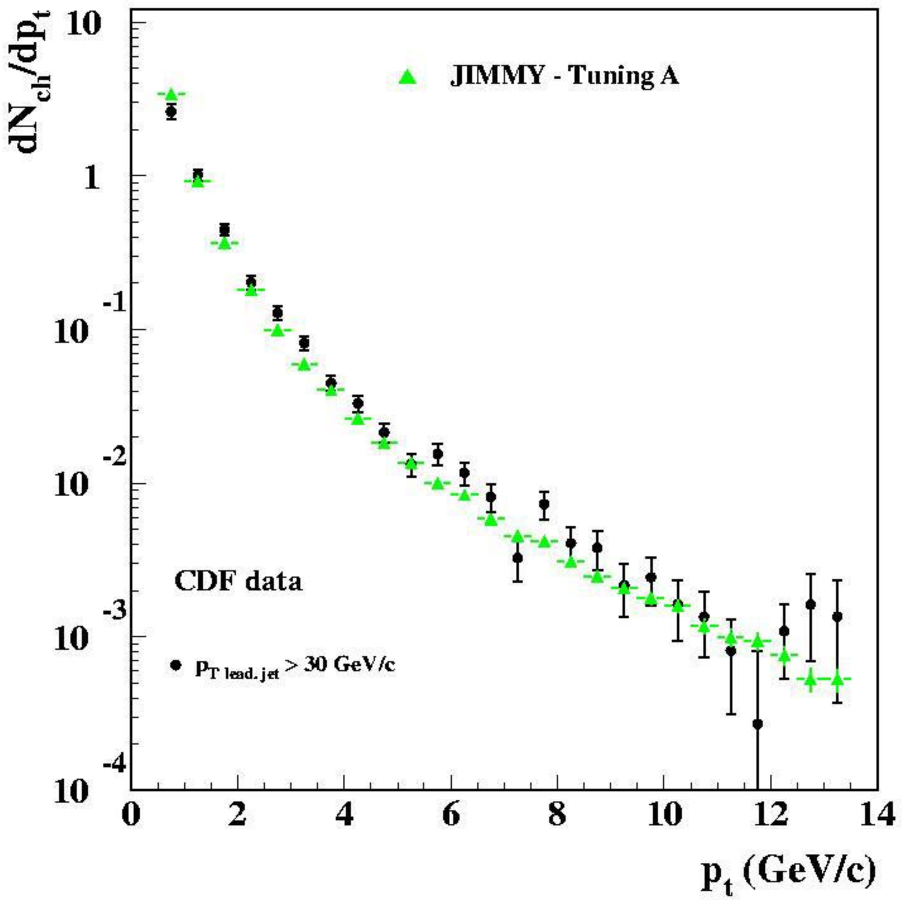
PARP(67)=1

JIMMY – "Tuning A" predictions

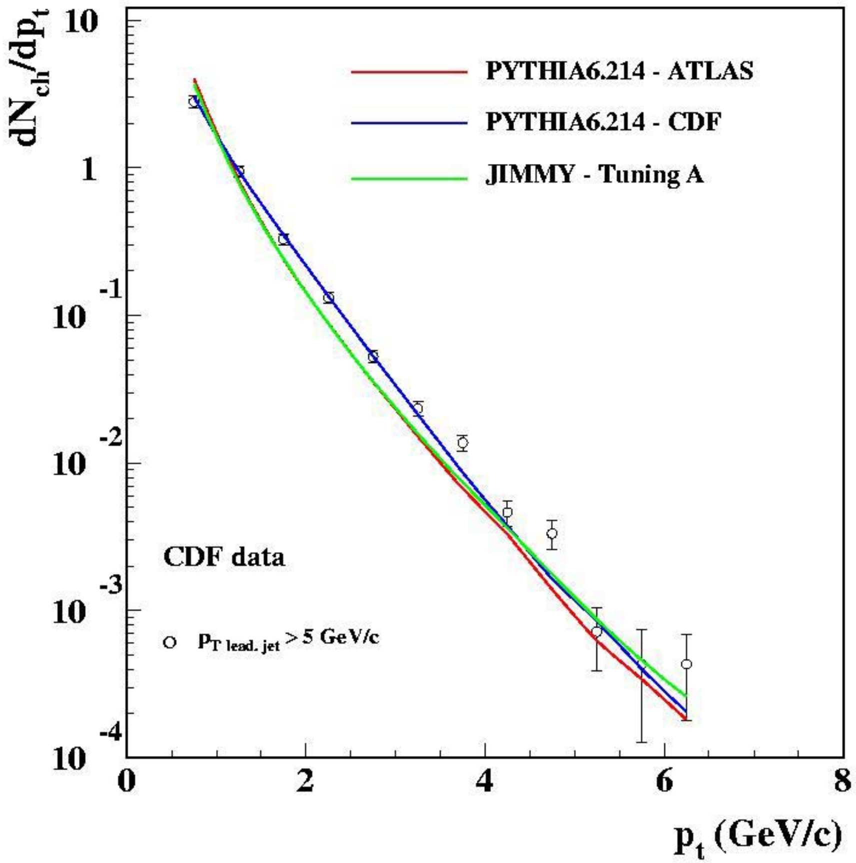
JIMMY – Tuning A
JMUEO=0
PTMIN=3.0
JMRAD(73)=3x0.71

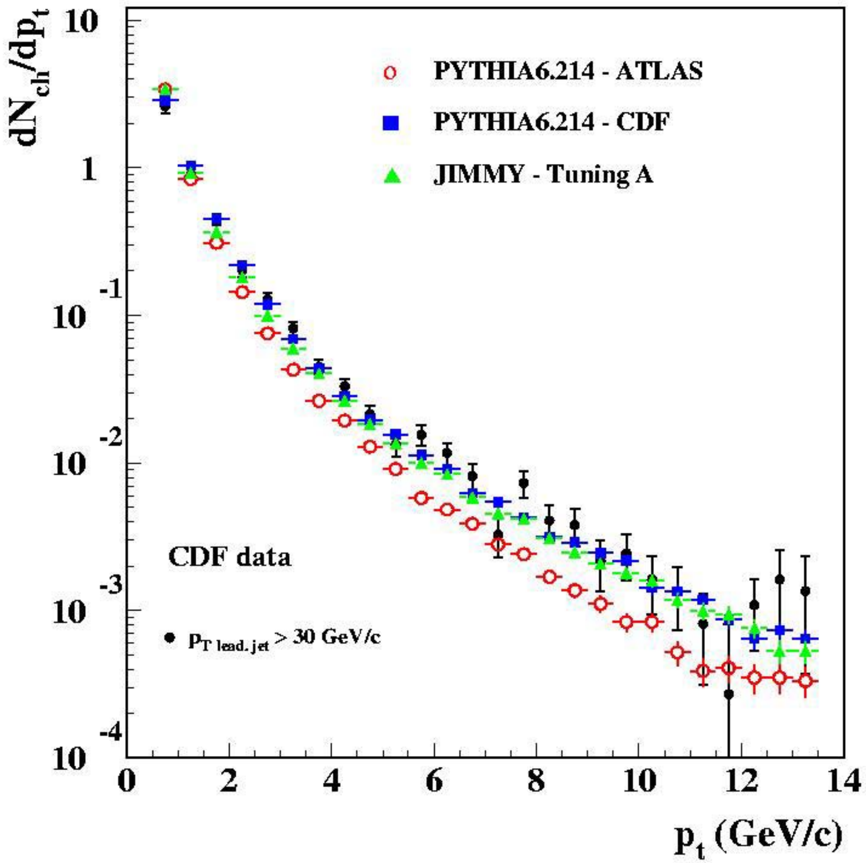
Proton radius shrunk by 1.73





Comparing underlying event tunings



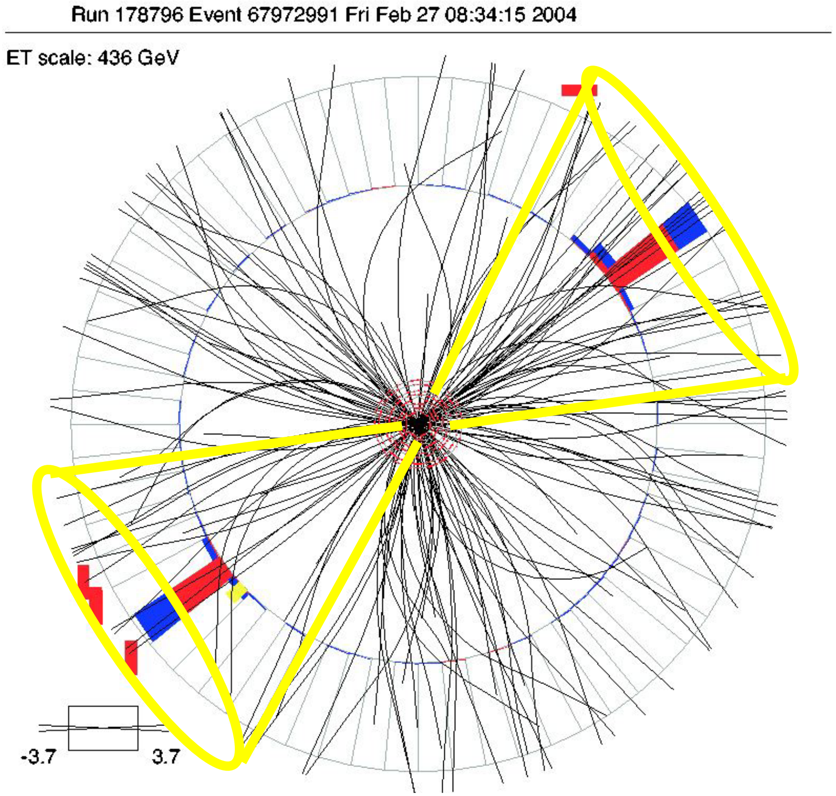


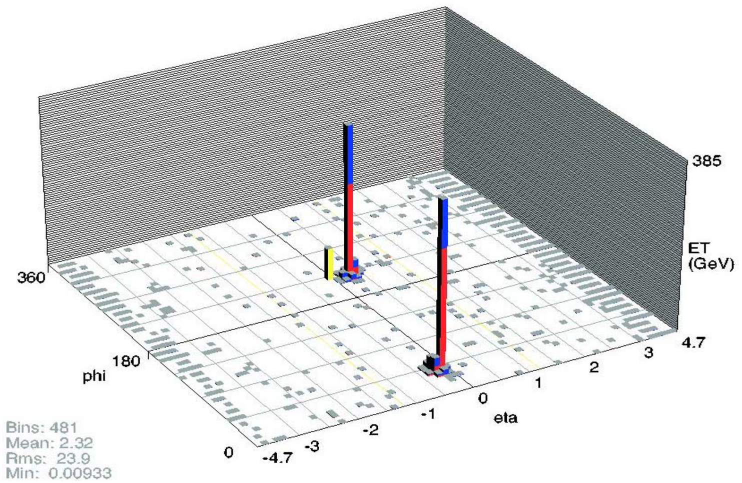
Good agreement between models and data for $p_T$ljet > 5 GeV.

For $p_T$ljet > 30 GeV JIMMY and PYTHIA tunings with increased PARP(67) better describe the data.

Dijet azimuthal decorrelation

hep-ex/0409040 Sep. 2004





Jets are defined in the central region using seed-based cone algorithm (R=0.7)

leading jet p_T^{max} > 75 GeV
second leading jet p_T^{max} > 40 GeV
both leading p_T jets: $|y_{jet}|$ < 0.5

Dijet production in hadron-hadron collisions result in $\Delta\phi_{dijet} = \phi_{jet1} - \phi_{jet2} = \pi$ in the absence of radiative effects.

$\Delta\phi_{dijet} = \pi$ → exactly two jets, no further radiation

$\Delta\phi_{dijet}$ small deviations from π → additional soft radiation outside the jets

$\Delta\phi_{dijet}$ as small as $2\pi/3$ → one additional high-p_T jet

small $\Delta\phi_{dijet}$ – no limit → multiple additional hard jets in the event

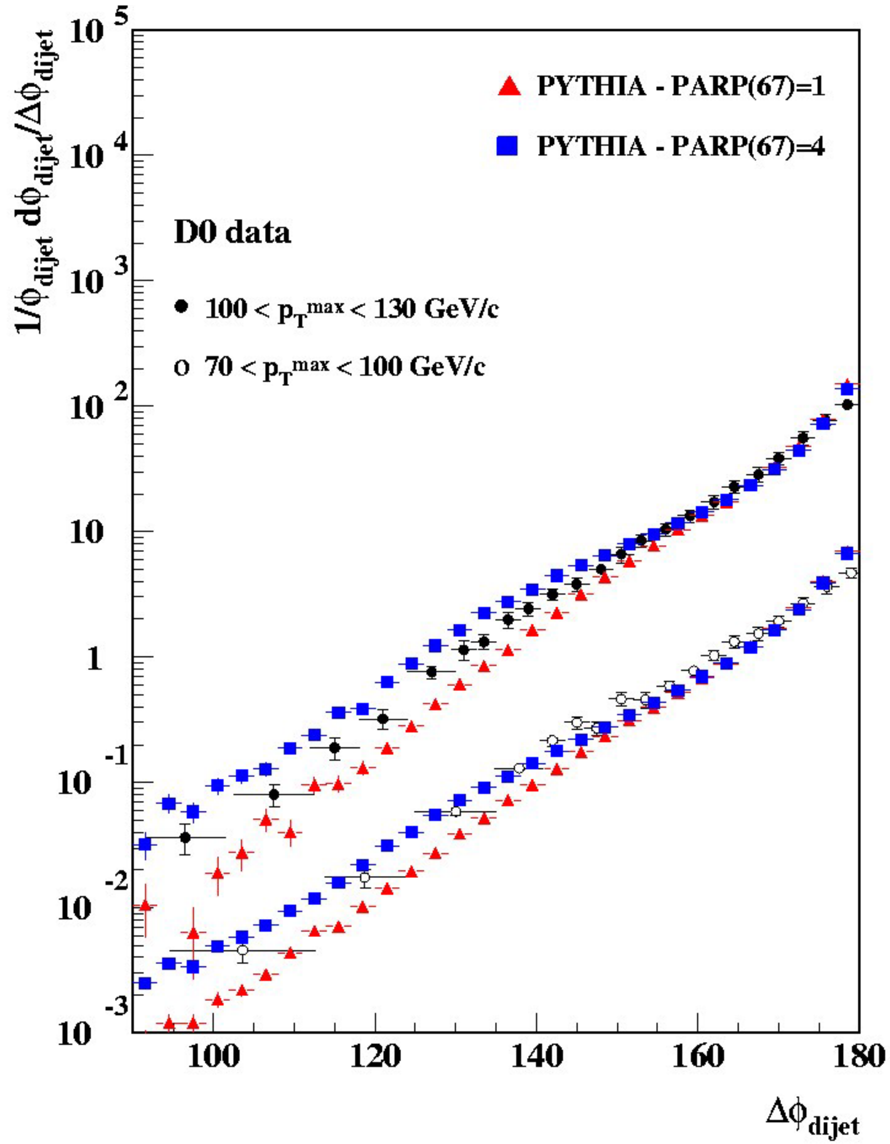
Dijet azimuthal decorrelation

PARP(67) defines the maximum parton virtuality allowed in ISR showers
($PARP(67) \times$ hard scale Q^2)

PARP(67)=1 (default): distributions underestimate the data! Need to increase the decorrelation effect, i.e. increase radiative and multiple interaction effects.

Increasing PARP(67) (from 1 to 4) the azimuthal decorrelation is increased.

Best value is somewhere between PARP(67)= 1 and 4!



Conclusions:

- **Monte Carlo tunings for the underlying event which agree for average properties of the underlying event, may not agree for more specific distributions** (also seen for minimum-bias distributions, e.g KNO-style distributions)**.**

- **p_T distributions of particles from the underlying event show that parton shower effects need to be tuned in addition to $p_T$min and the hadronic matter distributions.**

- **JIMMY – Tuning A describes the p_T distributions for particles in the underlying event.**

- **Future PYTHIA tunings should take into account the tuning of PARP(67) as indicated by data of both soft (CDF – UE) and hard (D0 – dijet azimuthal decorrelation) processes.**