Unpolarized Gluon Uncertainties and Direct Photon Measurements

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This talk described three topics: 1) the uncertainty on unpolarized gluons using just deep-inelastic scattering and Drell-Yan data, 2) the soft gluon effects in direct photon measurements, and 3) the details of the CDF direct photon measurement.

In reference [1], the uncertainty of the gluon distribution was studied using only deep-inelastic and Drell-Yan data sets. The parameters of the gluon distribution were varied systematically, and all of the other quark and gluon parameters were refit. Each variation was studied in detail, and the resulting band of acceptable gluon distributions provided an uncertainty estimate. The range of gluons was a relatively small 10% below $x < 0.1$, but grows to $\approx 50\%$ at larger values of x.

Direct photon data, in principle, could be used to reduce this uncertainty. But the release of the final E706 data [2] shows a deviation from NLO QCD of up to $\times 4$, much larger than the uncertainty of the gluon. This is attributed to the soft-gluon effects that are seen in heavy flavor and Drell-Yan data sets.

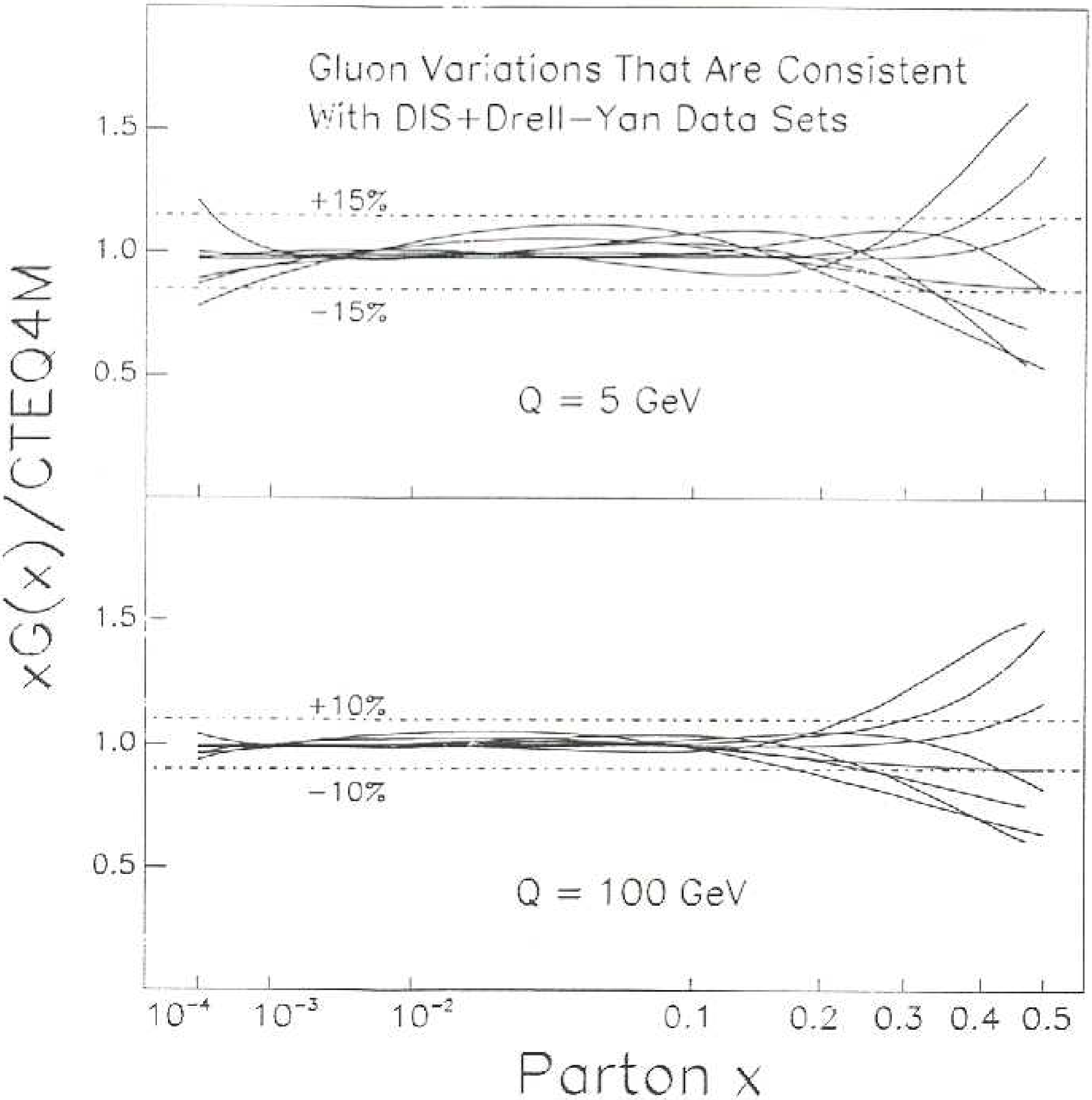
Finally, the CDF direct photon measurements [3] were described in detail. The detector is very similar to the STAR detector. The measurements used two independent methods of subtracting backgrounds, one which utilized transverse shower shapes, and the other which used photon conversion probabilities. The two methods agreed. Three main problems in performing the analysis were described: 1) GEANT did not provide an adequate simulation for either method, 2) the need to reconstruct mesons and compare to simulations, and 3) backgrounds that could not be attributed to the normal meson decays into photons. The CDF solutions to these three problems was described.

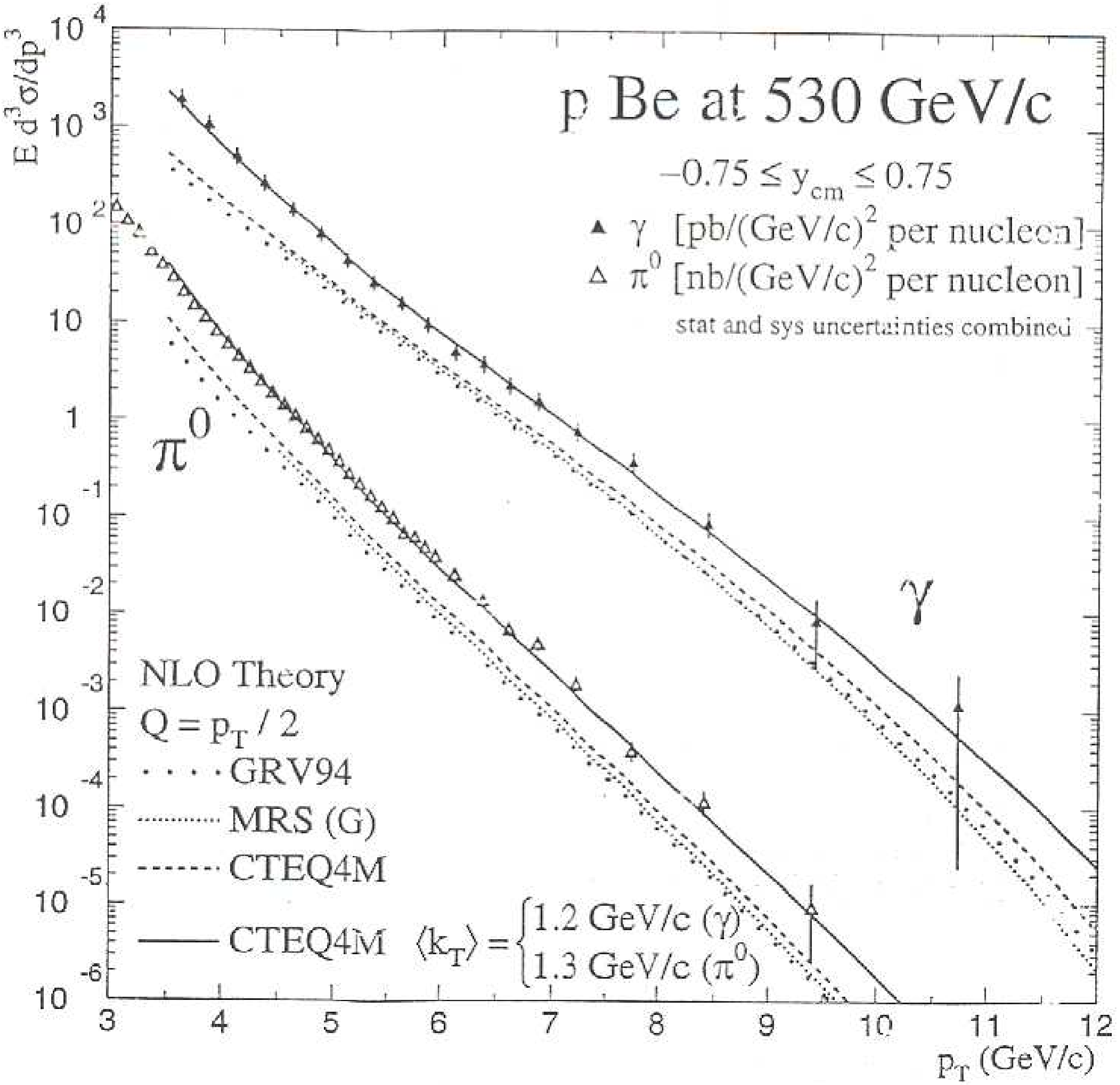
References

[1] J. Huston et al., hep-ph/9801444

[2] E706 Collaboration, hep-ex/9711017

[3] CDF Collaboration, PRL73:2662, PRD48:2998


Gluon Variations That Are Consistent
With DIS+Drell-Yan Data Sets
+15%
-15%
Q = 5 GeV
+10%
-10%
Q = 100 GeV
1.5
1.0
0.5
xG(x)/CTEQ4M
10⁻⁴
10⁻³
10⁻²
0.1
0.2
0.3
0.4
0.5
Parton x


p Be at 530 GeV/c
−0.75 ≤ y_cm ≤ 0.75
▲ γ [pb/(GeV/c)^2 per nucleon]
△ π^0 [nb/(GeV/c)^2 per nucleon]
stat and sys uncertainties combined
E d^3σ/dp^3
p_T (GeV/c)
π^0
γ
NLO Theory
Q = p_T / 2
GRV94
MRS (G)
CTEQ4M
CTEQ4M ⟨k_T⟩ = 1.2 GeV/c (γ)
1.3 GeV/c (π^0)

Bottom Line on Kt Effect

Most Recent MRS Analysis Applies Kt Corrections For Direct Photons

Range of Gluons Provided Varying Kt Amount

Range is as Large as the CTEQ Band, Which Only Used DIS+DY Data

Need Direct Photon Pt Resummation

For $\sqrt{s} = 200 - 500$, Expect All NLO QCD Predictions to Need an Additional 2-3 GeV of Kt

Ask Yourself, Does it Matter?

Details of the CDF Direct Photon Measurements

Refs: PRL73:2662 and PRD48:2998

Data at Both $\sqrt{s}$ =1800 and 630 GeV

Detector Very Similar to STAR

Two Independent π^0 Subtraction Methods

Electromagnetic Shower Shape γ vs π^0

Count $\gamma \rightarrow e^+e^-$ Conversions In Preshower Det.

CDF Direct Photon Conclusions

Simulations Can Be Non-Trivial to Develop

Early (Online?) Comparison With
Reconstructed Mesons Is Useful

Isolation Useful to Check Background Mix