The Benefits of Running at 140 GeV and again at 200 GeV

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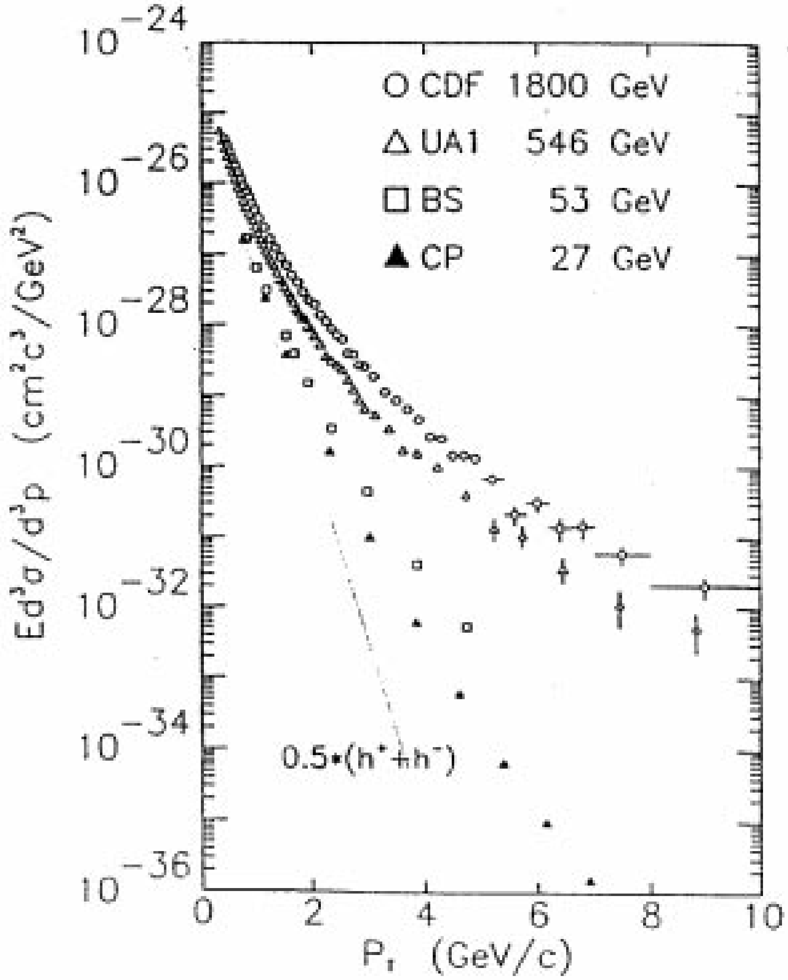
- A high p_T pizero spectrum with order of 1000 events for $p_T > 10$ GeV/c can be obtained with a 20 μb^{-1} run in Au+Au collisions at $200A \cdot$ GeV.
- The predictions of Xin-Nian Wang [Phys. Rev. C58 (1998) 2321] for the effect of jet quenching with $dE/dx = 0.25$ GeV/fm give a spectrum which deviates from the pure pQCD spectrum by a decreasing fraction as p_T increases.
- It will be difficult to distinguish the 'jet quenching' effect from a systematic error in the absolute p_T scale if the only thing to compare to our data is a theoretical prediction.
- A preferred method, which I proposed without success to Xin-Nian in November 1999, would be to make measurements at $\sqrt{s} = 140A \cdot$ GeV and $200A \cdot$ GeV and to test whether the data at the two c.m. energies obey the x_T scaling of pQCD.
- I assume that the 'jet quenching', which is, I think, a fixed energy loss ($dE/dx = \epsilon$ GeV/fm) independent of p_T and $\sqrt{s}$, will break the x_T scaling in a characteristic way.
- If this is true, it will allow a clear and unambiguous observation of the effect with the least systematic error and without the need for detailed theoretical predictions.

My Best Bet on Discovering QGP
Utilizes semi-Inclusive π^0 or $\pi^{\pm}$ production



Invariant cross section for non-identified charged-averaged hadron production at 90° in the c.m. system as a function of the transverse momentum p_T tablulated by CDF for a range of C.M. energies $\sqrt{s}$. There is an exponential tail (e^{-6p_T}) at low p_T, which depends very little on $\sqrt{s}$. This is the soft physics region, where the hadrons are fragments of 'beam jets'. At higher p_T there is a power-law tail which depends very strongly on $\sqrt{s}$. This is the hard-scattering region, where the hadrons are fragments of the high p_T QCD jets from constituent-scattering. **My hope is that the QGP causes the high p_T quarks to lose all their energy and stop, so that the high p_T tail will 'vanish' for central Au+Au collisions**

In RHI central collisions, leading particles are the only way to find jets because in one unit of Δr there is $\pi \times \frac{1}{2\pi}\frac{dE_T}{d\eta} \sim 375$ GeV !!!.

From:

http://www.phenix.bnl.gov/phenix/WWW/publish/sapin/conferences/hardscat99/

First prediction using 'QCD' 1975

R. F. Cahalan, K. A. Geer, J. Kogut and Leonard Susskind
Phys. Rev. **D11**, 1199 (1975)

Asymptotic freedom and the "absence" of vector-gluon exchange in wide-angle hadronic collisions

- ♡ **Abstract:** The naive, pointlike parton model of Berman, Bjorken and Kogut is generalized to scale-invariant and asymptotically free field theories. The asymptotically free field generalization is studied in detail. Although such theories contain vector fields, single vector-gluon exchange contributes insignificantly to wide-angle hadronic collisions. This follows from (1) the smallness of the invariant charge at small distances and (2) the *breakdown of naive scaling* in these theories. These effects should explain the apparent absence of vector exchange in inclusive and exclusive hadronic collisions at large momentum transfers observed at Fermilab and at the CERN ISR.
- ♡ An interesting **Acknowledgement:** ... Two of us (J. K. and L. S. also thank S. Brodsky for *emphasizing to us repeatedly* that the present data on wide-angle hadron scattering *show no evidence for vector exchange.*

♡ Nobody's perfect, they get *one* thing right! They introduce the "effective index" $n(x_T, \sqrt{s})$ to account for 'scale breaking':

$$E\frac{d^3\sigma}{dp^3} = \frac{1}{p_T^{n(x_T,\sqrt{s})}} F(\frac{p_T}{\sqrt{s}}) = \frac{1}{\sqrt{s}^{\,n(x_T,\sqrt{s})}}\, G(\frac{p_T}{\sqrt{s}}) \qquad (1)$$

CCOR 1978—Discovery of "REALLY High $p_T > 7$ GeV/c"

A. L. S. Angelis, et al., Phys. Lett. **79B**, 505 (1978)
See also, A. G. Clark, et al., Phys. Lett. **74B**, 267 (1978)

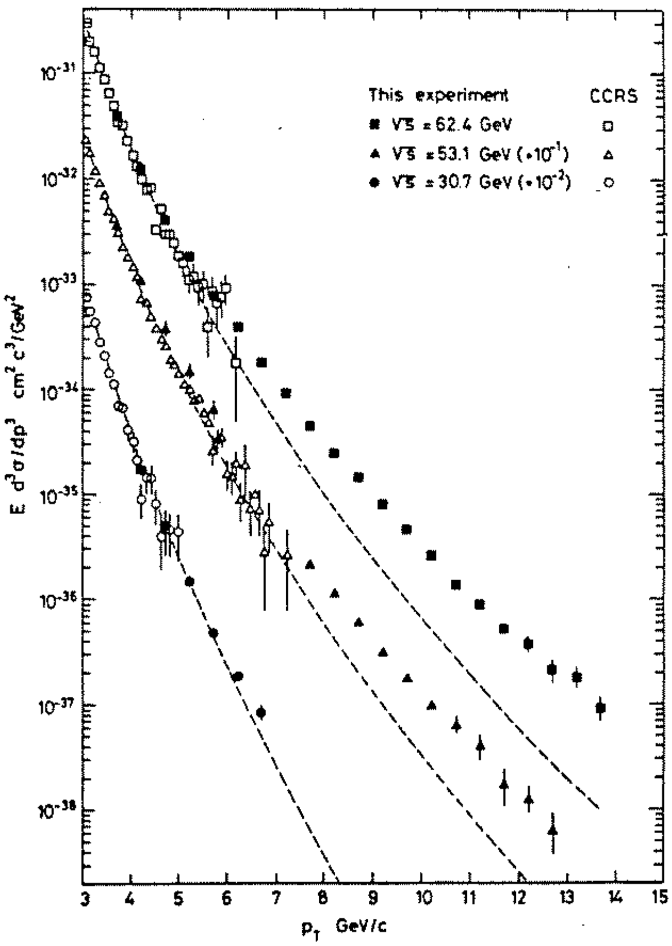


Figure 1: CCOR transverse momentum dependence of the invariant cross section for $p + p \to \pi^0 + X$ at three center of mass energies. Cross sections are offset by the factors noted. Open points and dashed fit are from a previous experiment, CCRS, F. W. Büsser, et al., Nucl. Phys. **B106**, 1 (1976).

♡ $Ed^3\sigma/dp^3 \simeq p_T^{-5.1\pm0.4}(1 - x_T)^{12.1\pm0.6}$, for $7.5 \leq p_T \leq 14.0$ GeV/c, $53.1 \leq \sqrt{s} \leq 62.4$ GeV (including *all* systematic errors).

$n(x_T, \sqrt{s})$ **WORKS,** $n \to 5 = 4^{++}$

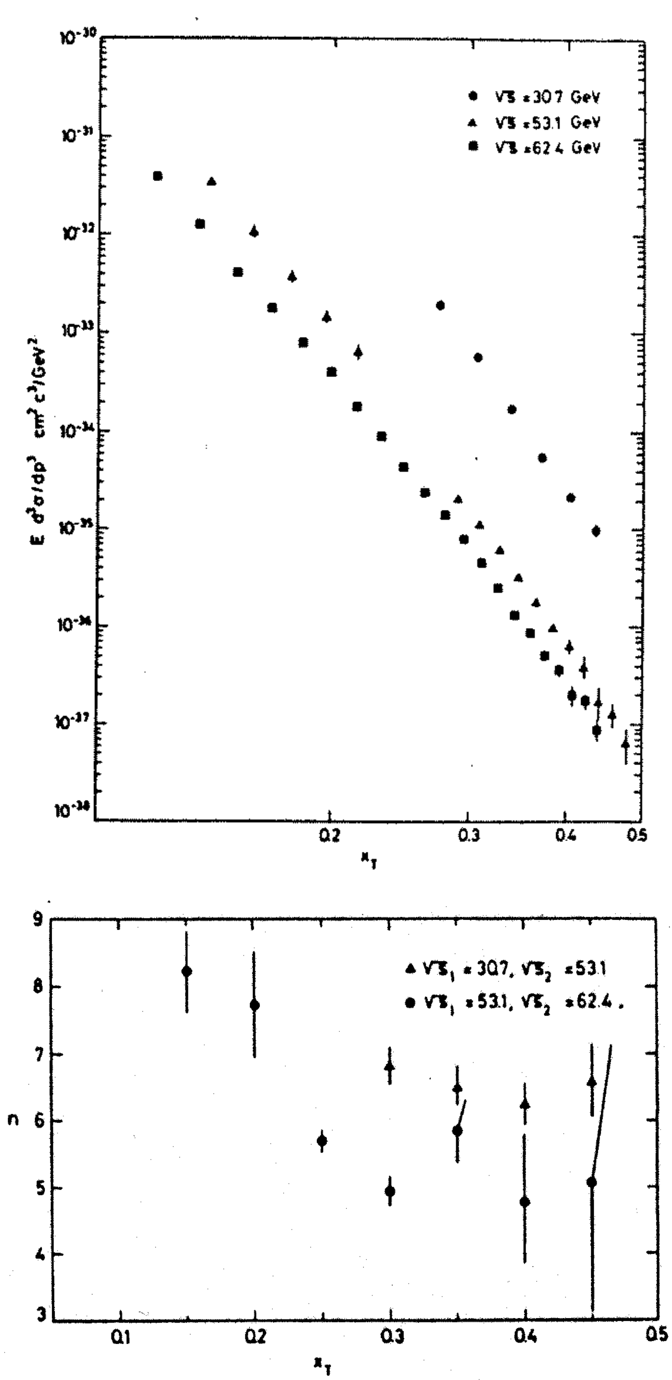
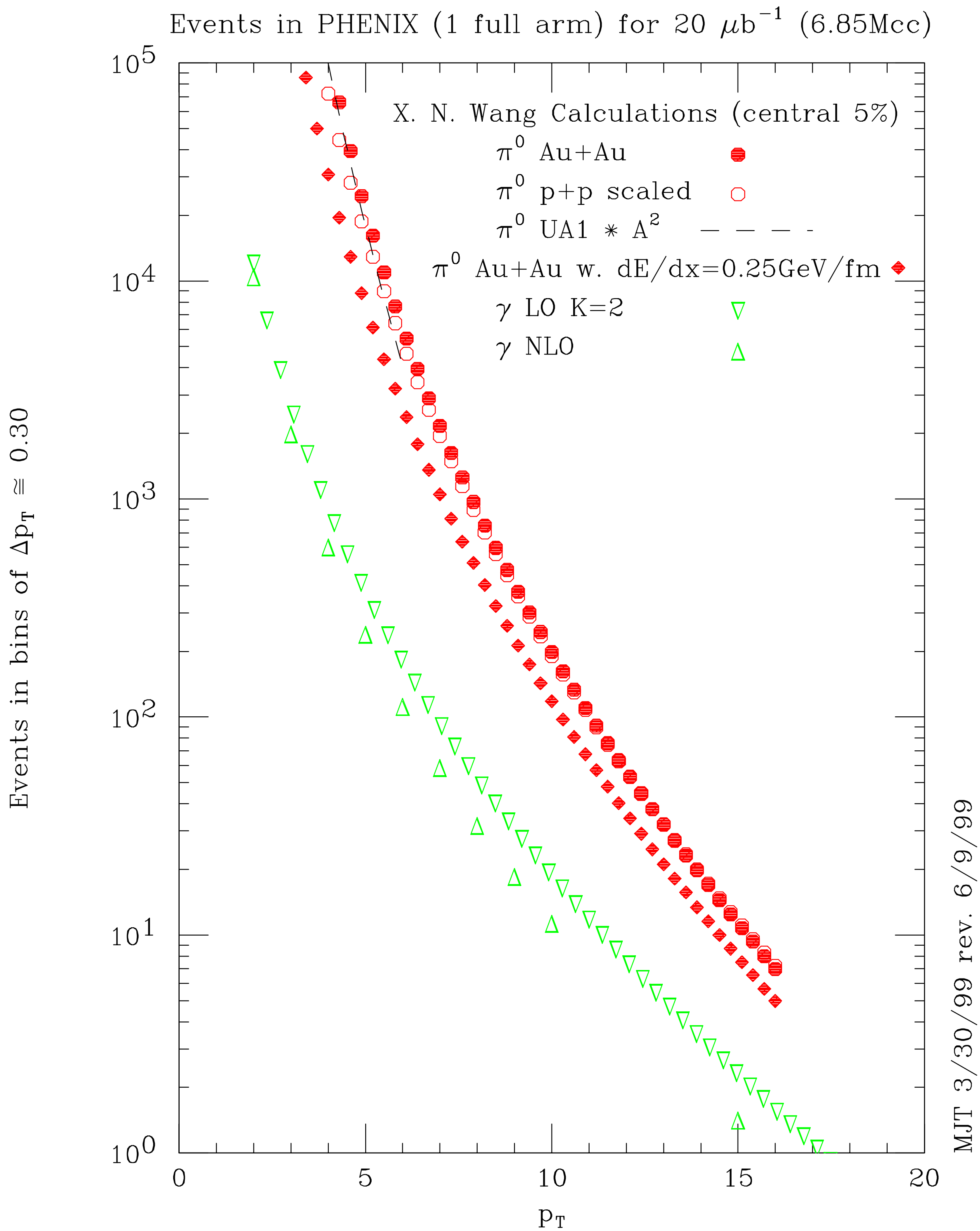


Figure 2: Top(t): CCOR invariant cross section vs $x_T = 2p_T/\sqrt{s}$. Bottom(b): $n(x_T, \sqrt{s})$ derived from the combinations indicated. *The systematic normalization at* $\sqrt{s} = 30.6$ *has been added in quadrature. Note: the absolute scale uncertainty cancels!*

X-N Wang's predictions at $\sqrt{s} = 200A \cdot \mathrm{GeV}$



X-N Wang's predictions at $\sqrt{s} = 200A \cdot \mathrm{GeV}$ Log-Log plot