Underlying event

Is a high $p_\perp$ event = 2 jets + min. bias ?

Correlations

Uncorrelated subcollisions $\Rightarrow$

Prob. (n subcollisions) = Poisson distrib.

$$\therefore \quad P(2) = \frac{1}{2} P^2(1)$$

double counting

$$P(2) = \frac{\sigma_2}{\sigma_{inel,nd}} \quad ; \quad P(1) = \frac{\sigma_1}{\sigma_{inel,nd}}$$

$$\therefore \quad \sigma_2 = \frac{1}{2} \frac{\sigma_1^2}{\sigma_{inel,nd}}$$

Exp. notation: $\sigma_2 = \frac{1}{2} \frac{\sigma_1^2}{\sigma_{eff}}$

ISR: $\sigma_{eff} \sim 5\,mb$ $(p_\perp > 4\,GeV)$ $\sigma_{nd} \sim 30\,mb$

CDF: $\sigma_{eff} \sim 12\,mb$ $(p_\perp > 25\,GeV)$ $\sigma_{nd} \sim 50\,mb$

CDF $3j+\gamma$ $\sigma_{eff} \sim 14\,mb$

$\sigma_{eff} << \sigma_{nd}$ $\Rightarrow$ Correlated mult. coll.

1 hard coll. ⇒ more likely to have another one.

Interpretation:

- Central coll. ⇒ many hard sub coll.
- Peripheral coll. ⇒ few — " —

Pedestal effect

High $p_\perp$ jets ⇒ Underlying event grows

UA1 fig

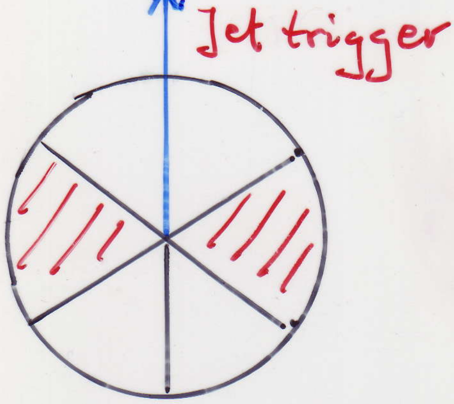
H1 resolved γ-prod

CDF Rick Field

Tuned PYTHIA MC to CDF data

Tune A, tune DW

give good fits to "all" data

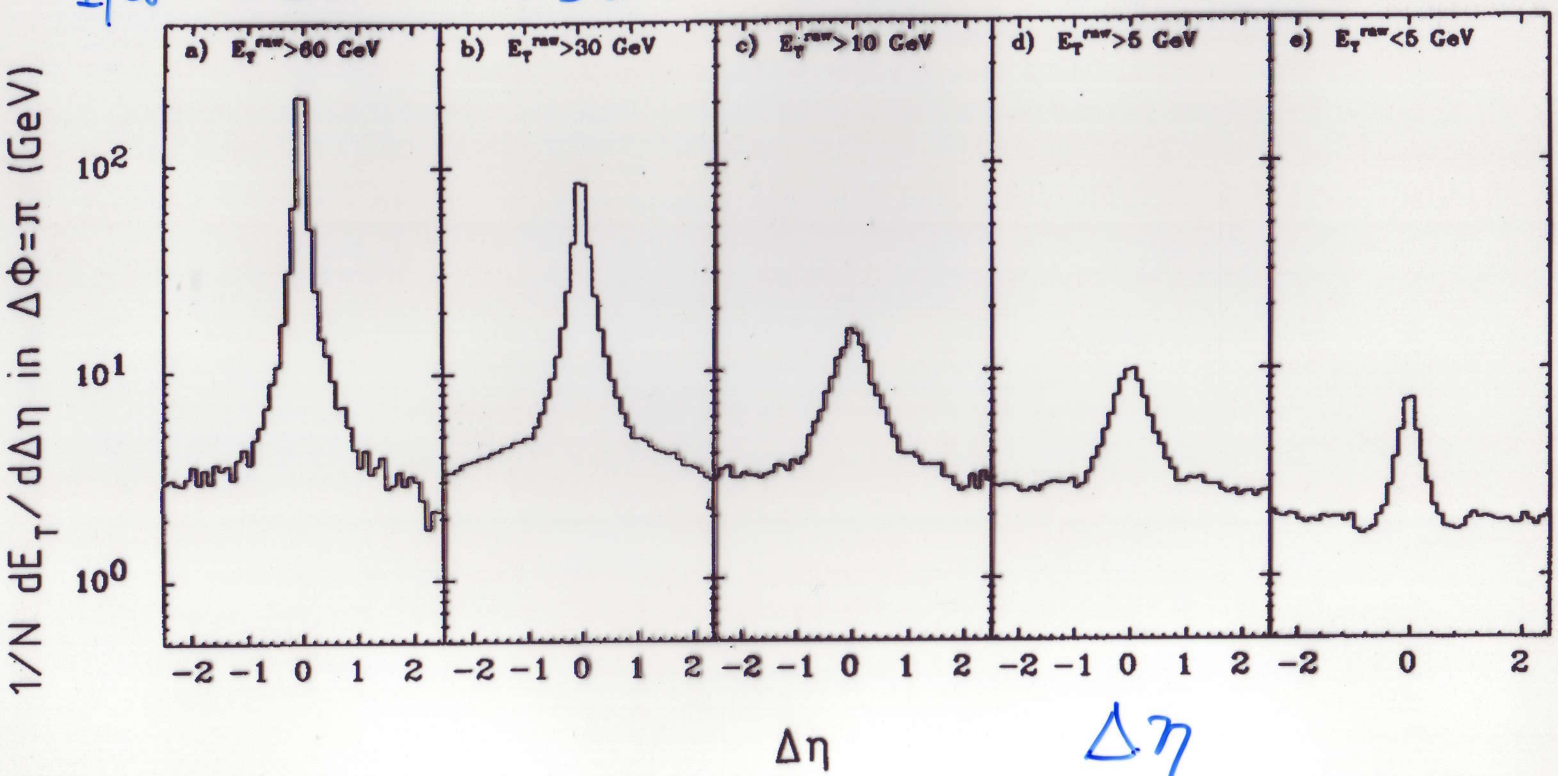


$E_\perp$ & charged mult. in transverse region

UA1

UA1

$E_{\perp jet}$ >60 >30 >10 >5 <5



$\Delta\eta$

FIG. 1

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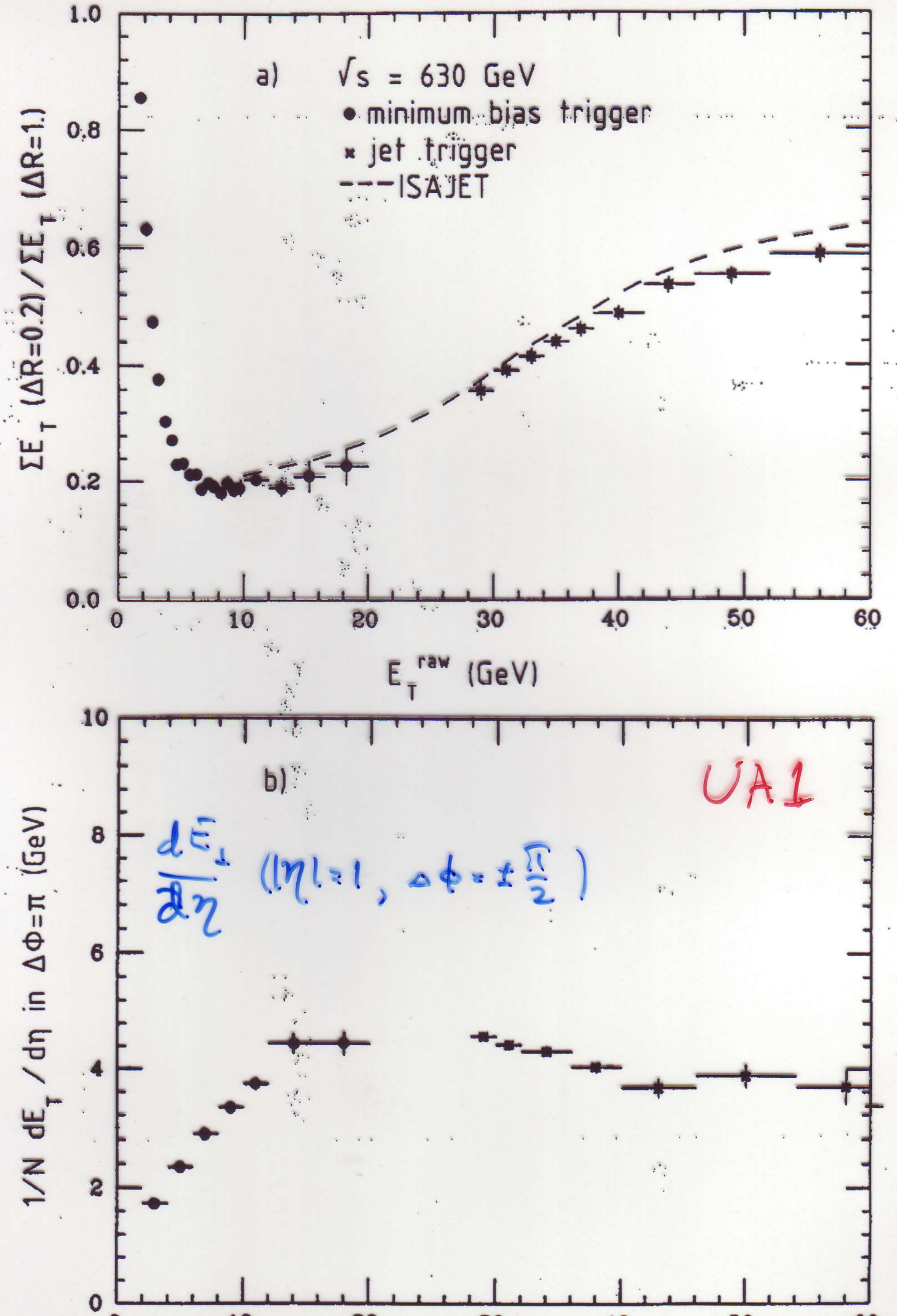
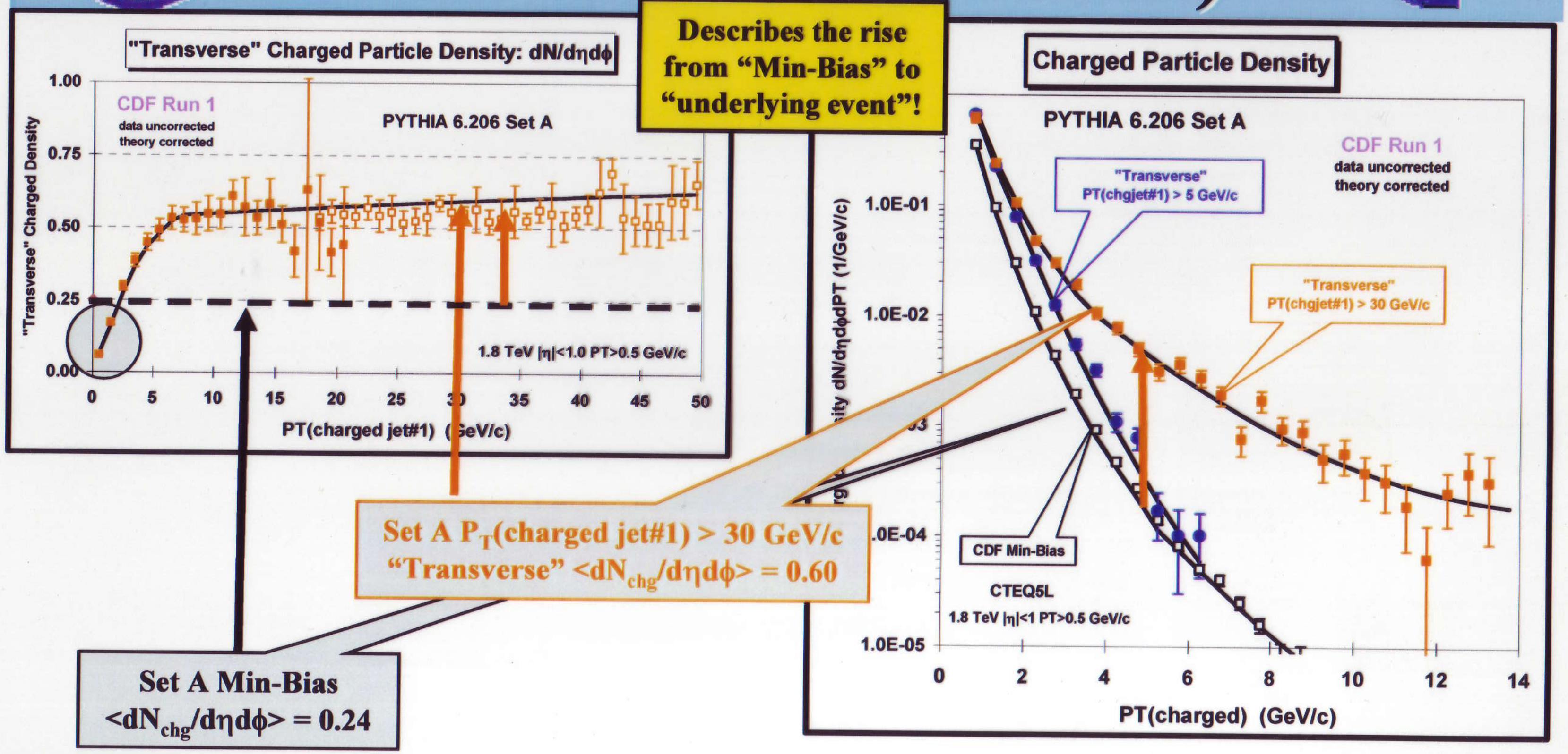


FIG. 2

$E_\perp$ jet

Rick Field

PYTHIA 6.206 Tune A (CDF Default)



- Compares the average "transverse" charge particle density ($|\eta|<1$, $P_T>0.5$ GeV) versus P_T(charged jet#1) and the P_T distribution of the "transverse" and "Min-Bias" densities with the QCD Monte-Carlo predictions of a tuned version of PYTHIA 6.206 (P_T(hard) > 0, CTEQ5L, Set A). Describes "Min-Bias" collisions! Describes the "underlying event"!

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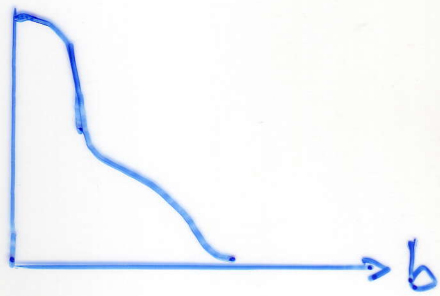
Early Sjöstrand - v. Zijl model implemented in PYTHIA

Assume: High energy collisions are dominated by parton-parton subcoll.

Min. bias: At least one parton-parton subcoll.

Parton distrib: ~ Double Gaussian



Fixed b: Poisson distrib.

< # subcoll. > $\propto$ overlap

$\Rightarrow$ $P(n) \approx$ Geometric distrib.

Wider than Poisson

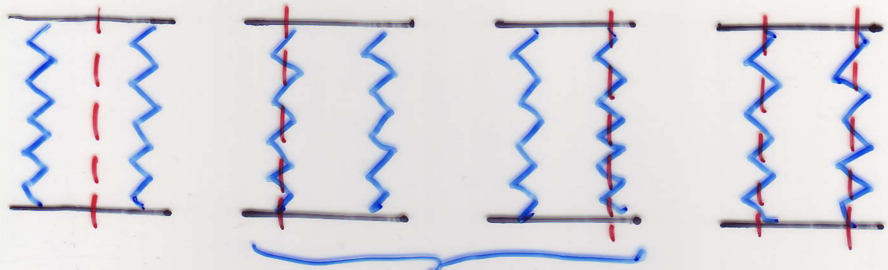
Note: Diffraction is not included

Multiple collisions and unitarity

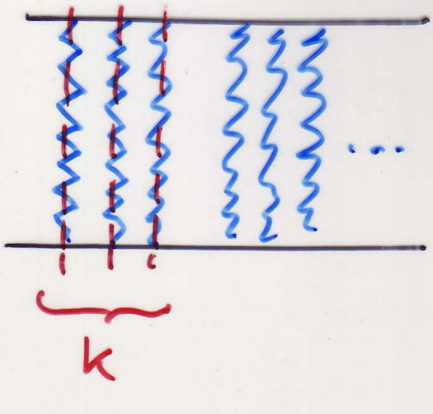
AGK cutting rules

$\mathbb{P}$ = gluon ladder

Double $\mathbb{P}$ exch.



1 : −4 : 2



k cut $\mathbb{P}$. Arbitrary # uncut $\mathbb{P}$ ⇒

Poisson distrib.: $e^{-\bar{X}} \frac{\bar{X}^k}{k!}$ (k ≠ 0)

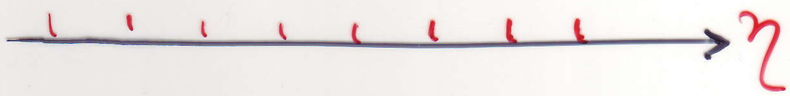
Cf. Pythia

Problems

Relation $E_\perp - n_{ch}$ not as expected.

Rick Field's tunes fit both $E_\perp$ flow and particle flow, but pay a price.

1 cut $\mathbb{P}$:



2 cut $\mathbb{P}$:

Double particle density expected

CDF data : $E_\perp$ grows more than the multiplicity

Rick's tunes: Color rearrangement