Multiple interactions at HERA II, what should we measure

hep-ex/9511012 29 Nov 1995

Jets and Energy Flow in Photon-Proton Collisions at HERA

Properties of the underlying event: the energy density outside the jets is determined depending on the fraction of the photon energy which is available to the hard scattering process. Correlations of the transverse energy are measured.

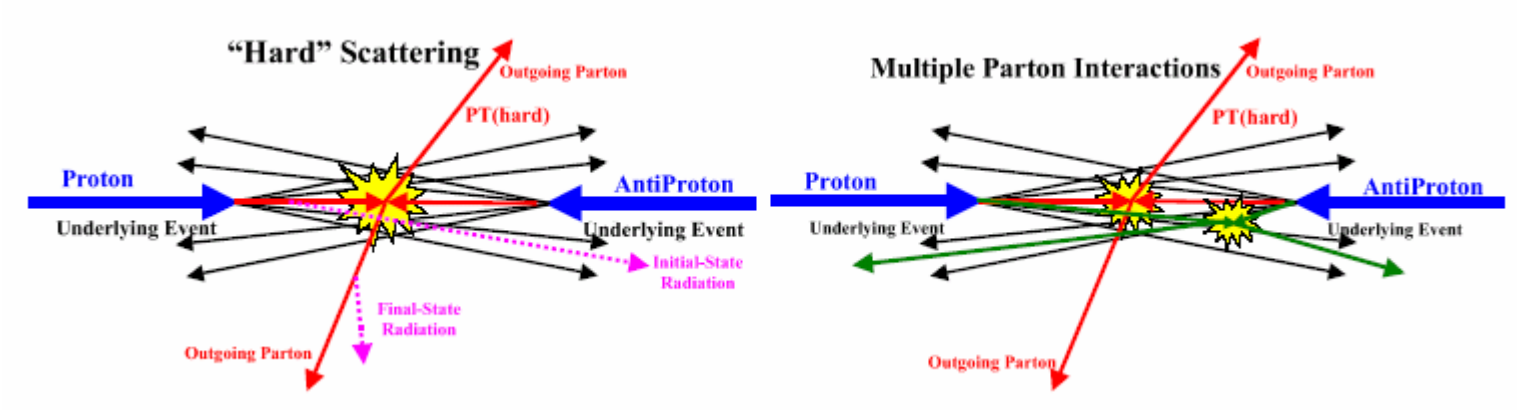
What else can be done ?

Can larger statistics help ?

Studies a la Tevatron i.e. energy flow outside jets in more detail – Osman, not very conclusive, MC does not describe the data, in general

New variables more sensitive to MI ?

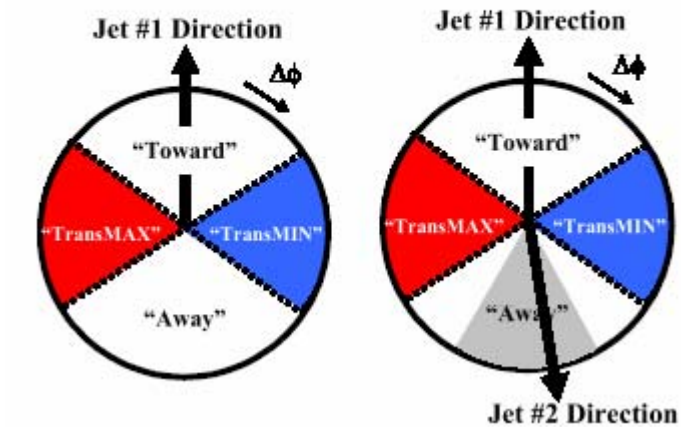
TEVATRON analysis of MI



Analysis aims to separate effect of MI from single hard scattering, ISR and FSR:

•Look into phase space (azimutal angle) outside 2 leading jets

•Remove effects of additional (third) jet choosing quadrant with smaller E_T



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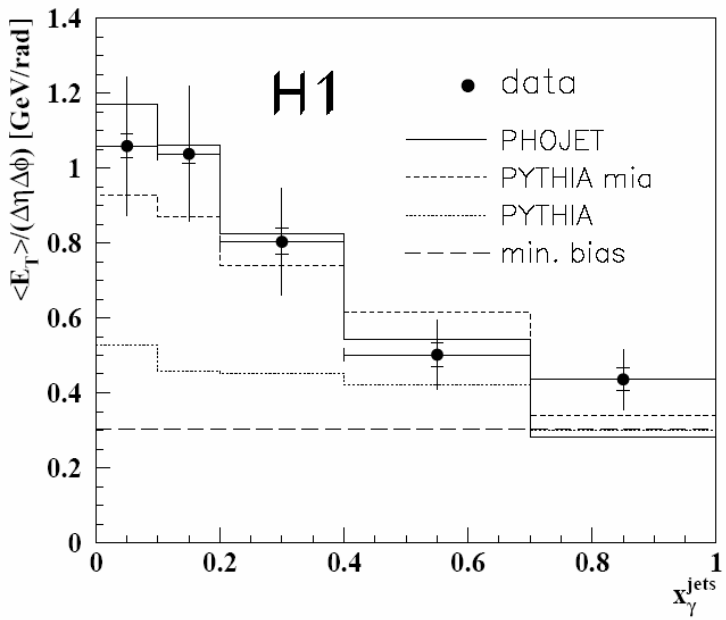
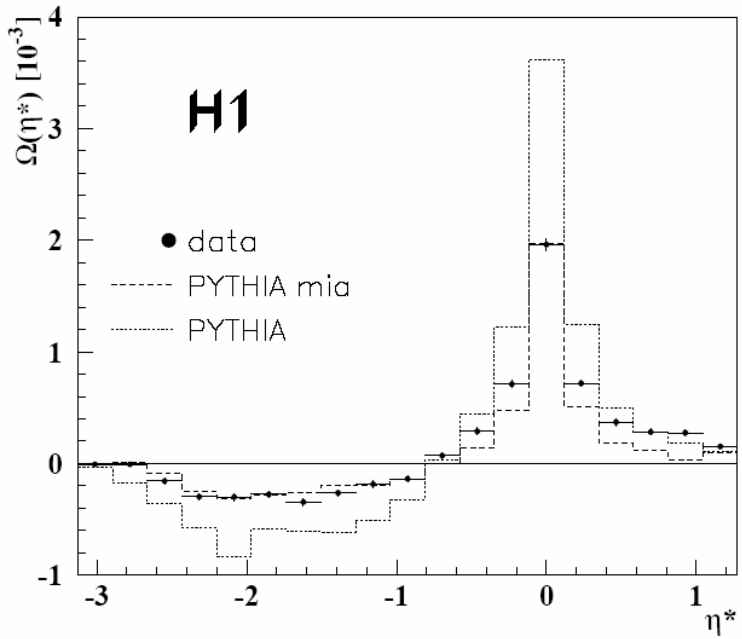




$$x_\gamma^{jets} = \frac{E_T^{jet1} e^{-\eta^{jet1}} + E_T^{jet2} e^{-\eta^{jet2}}}{2E_\gamma}$$

$$\Omega(\eta^*) = \frac{1}{N_{ev}} \sum_{i=1}^{N_{ev}} \frac{(< E_{T,\eta^*=0} > - E_{T,\eta^*=0,i})\,(< E_{T,\eta^*} > - E_{T,\eta^*,i})}{(E_T^2)_i}.$$

Possible improvements H1-type analysis of MI

E_T-E_T correlation function certainly carries more information, however effects of MI are strongly mixed with normal single-HI+ISR+FSR. In 1994 statistics was too low to exclude jets (only high total E_T sample (>20 GEV) was avialable with sufficient statistics). Also for reason of statistics (no jets) correlations in φ could not be done. To obvious improvements:

- remove leading jet energies from correlation function
- Use jet η as reference
- Correlation in φ space

} OBVIOUS

Beyond that : study dispersion – MI change shape of multiplicity (E_T distributions)

$$f(n;\langle n\rangle) = e^{-\langle n\rangle}\langle n\rangle^{n} \Big/ n!$$

$$D^2 = \langle n\rangle$$

$$KNO(n) = \int f(n, \overline{n(b)})\sigma(\vec{b})d^2\vec{b}$$

$$D_{KNO} \propto \langle n\rangle$$

Idea :

- width of multiplicity (or E_T) distributions should be particularly sensitive to MI
- Without MI width of distributions normalized to average value should not chage dramatically in phase space

1. Transverse energy dispersion in hcms, normalisation as for correlations $\Omega(\eta^*)$, ,jet energy included

$$D_1^2(\eta^*) = \frac{1}{N_{ev}} \sum_i \frac{\left(\left\langle E_{T\eta^*} \right\rangle - E_{T\eta^*}{}^i \right)^2}{\left(E_T{}^i \right)^2}$$

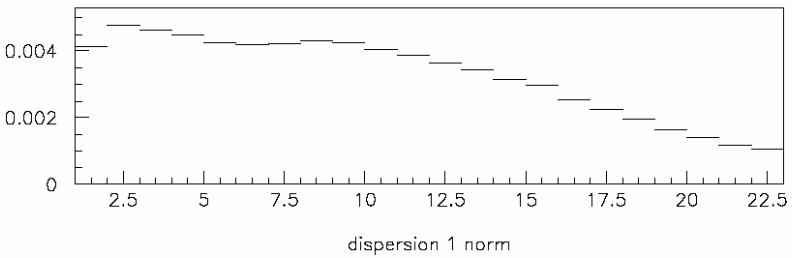
2. Transverse energy dispersion in hcms, 2 leading jets excluded, each bin of η^* normalized to average energy in this bin

$$D_2^2(\eta^*) = \frac{1}{N_{ev}} \sum_i \frac{\left(\left\langle E_{T\eta^*} \right\rangle - E_{T\eta^*}{}^i \right)^2}{\left\langle E_{T\eta^*} \right\rangle}$$

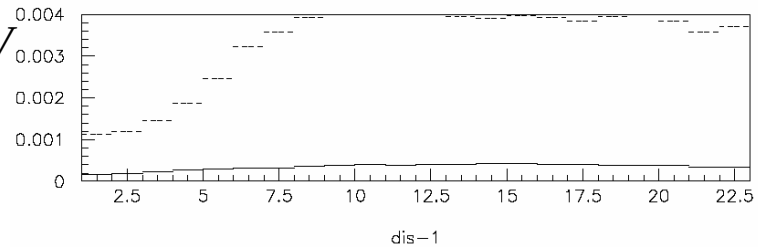
3. Transverse energy dispersion as a function of distance in pseudorapidity from leading jet, 2 leading jets excluded

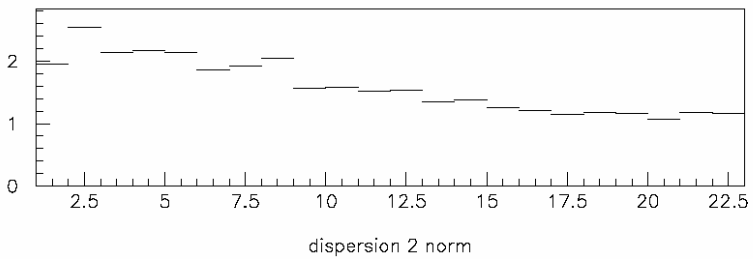
$$D_3^2(\eta^*) = \frac{1}{N_{ev}} \sum_i \frac{\left(\left\langle E_{T\Delta\eta^*} \right\rangle - E_{T\Delta\eta^*}{}^i \right)^2}{\left\langle E_{T\Delta\eta^*} \right\rangle}$$

Dispersion of E_T

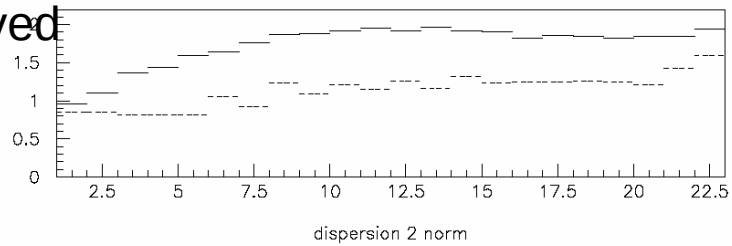


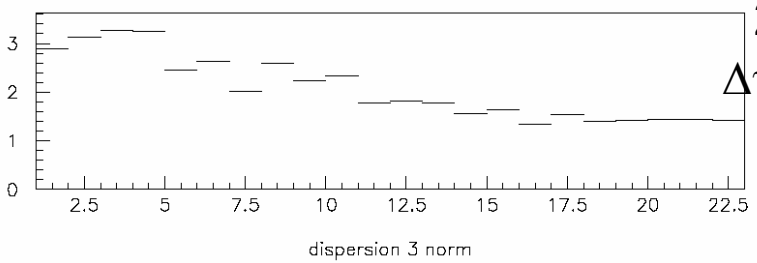
$E_T > 20GeV$



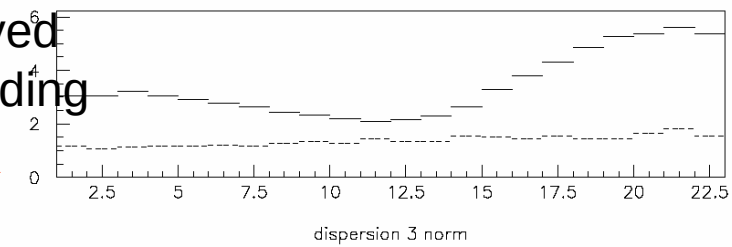


2 jets, removed η in hcms





2 jets, removed Δη rel. ηof leading jet



direct

Resolved mi-on (full) mi-off (dashed)

Conclusions

- $D^2/\langle E_T \rangle$ remarkably constant for resolved photoproduction without MI and huge effect of MI
- Before continuing this study it would be good to see first how behaves dispersion of E_T and multiplicity in resolved and direct photoproduction
- Correlations in φ in 2-jet sample (jet removed) (E_T,multiplicity)
- Normalized dispersions in bins of φ and $\Delta\eta$
- Sensitivity to MI parameters and mechanism (various mechanisms at present available only for pp