

Photoproduction of Protons



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H1 Collaboration

DIS2002

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Motivation

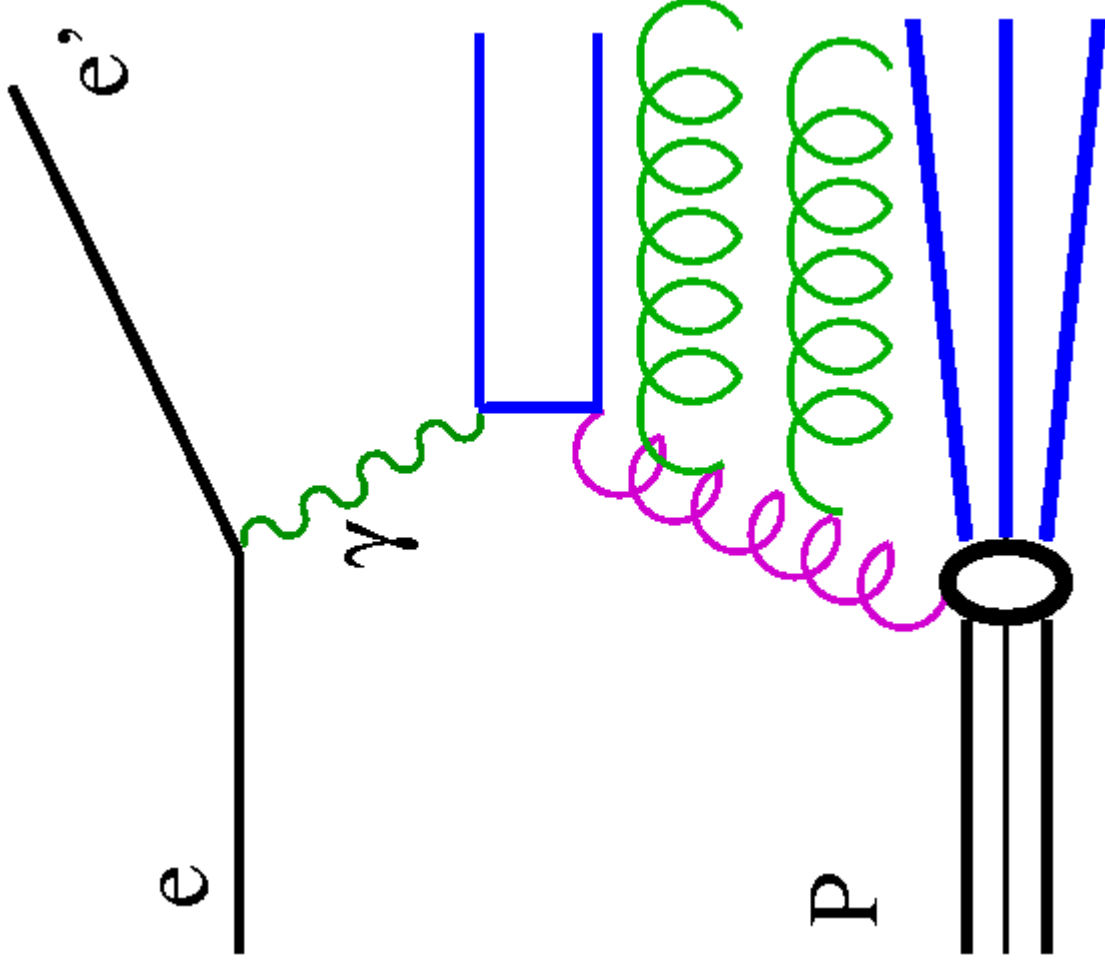
- Production of baryons in the central fragmentation region \implies laboratory to study effects in non-perturbative QCD.
- Well established MC Model for fragmentation, parameters tuned with e^+e^- data.

Is it applicable also in the HERA region,

with mainly gluonic environment

(mainly quark environment in e^+e^-) ?

Kinematics of the process



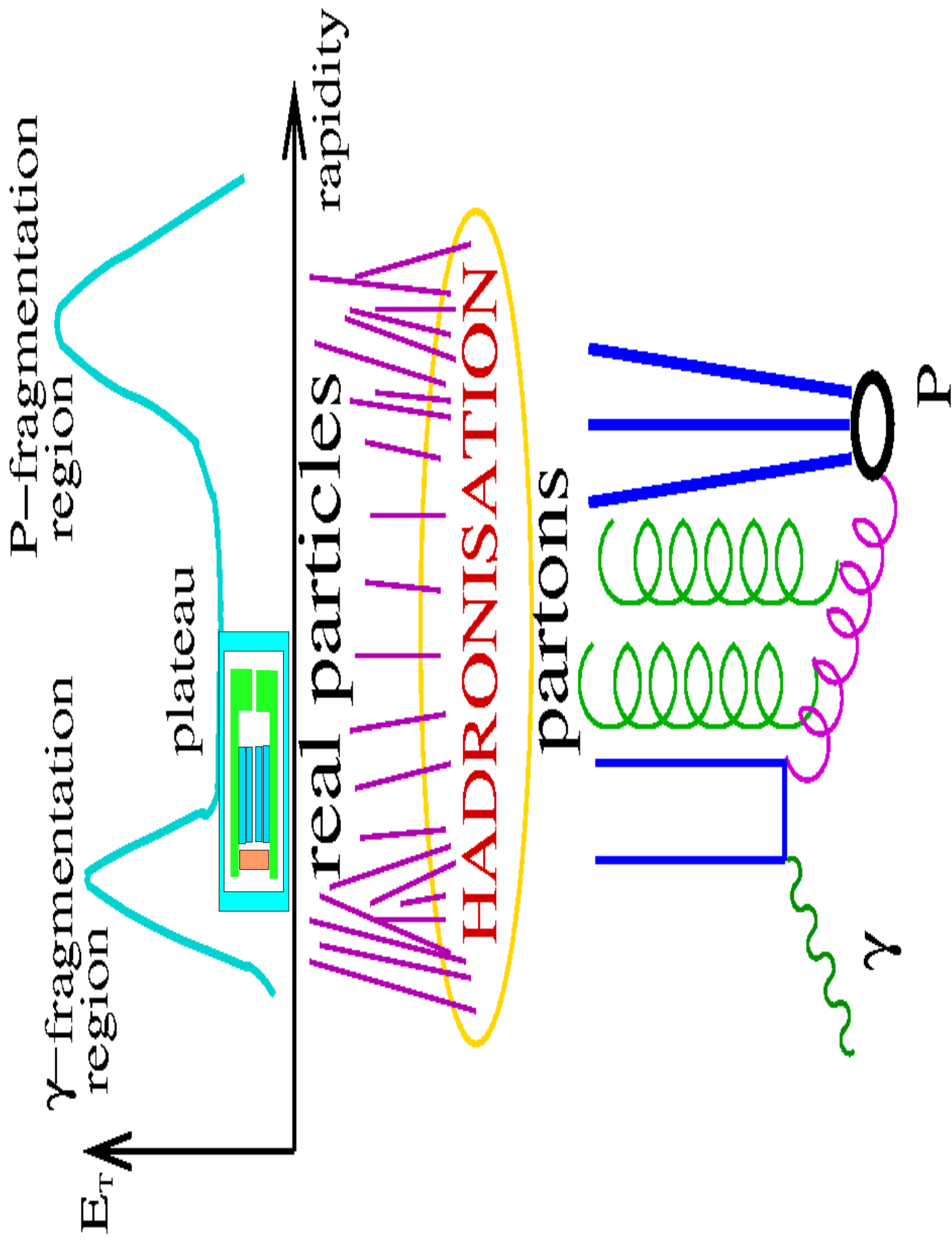
$$Q^2 = 4 E_e E_{e'} \cos^2\left(\frac{\theta}{2}\right)$$

$$y_e = 1 - \frac{E_{e'}}{E_e} \sin^2\left(\frac{\theta}{2}\right)$$

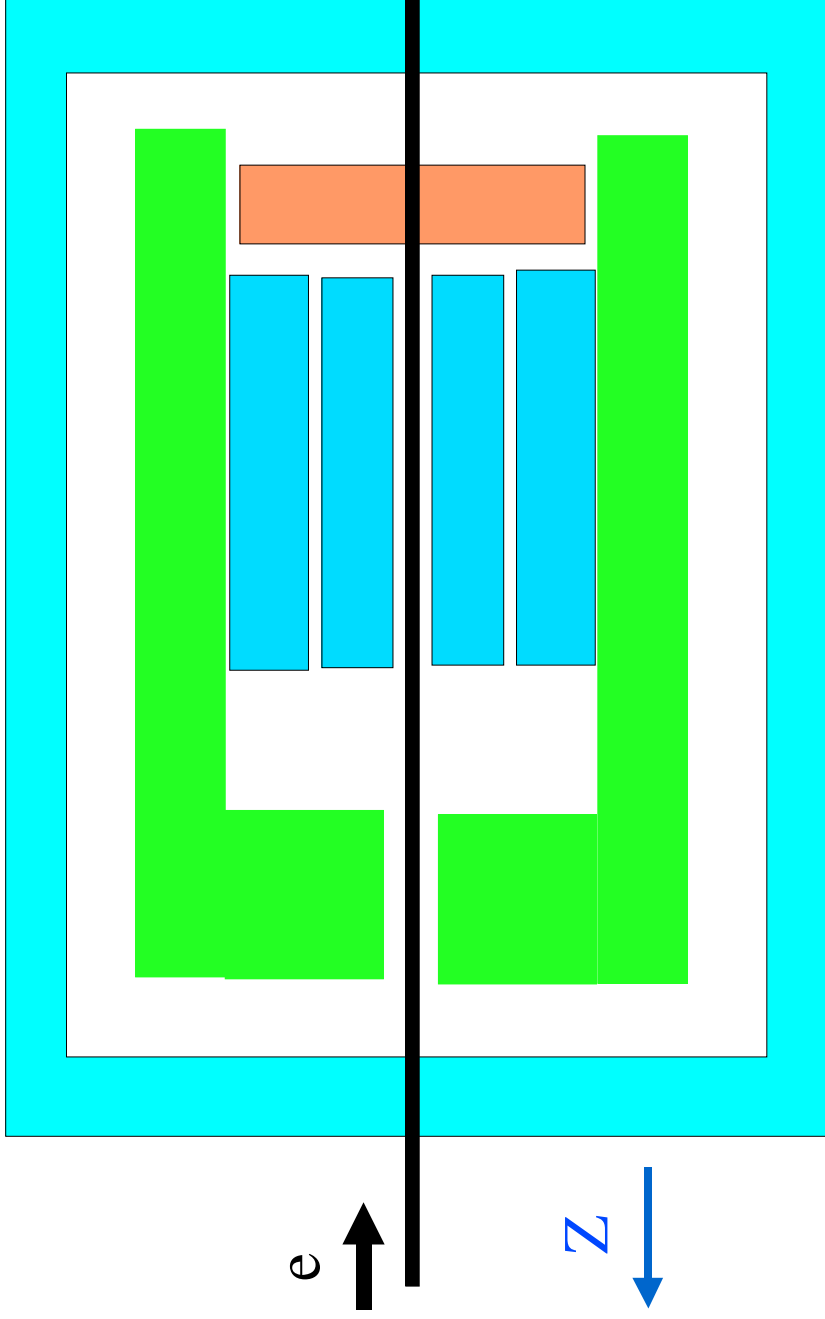
$$E_e = 27.5 \text{ GeV (e}^+)$$

$$E_p = 820 \text{ GeV}$$

$$\mathcal{L} = 6.0 \text{ pb}^{-1}$$



H1 detector



Rapidity of the initial proton : 7.5 units

Rapidity:

$$y = \frac{1}{2} \ln \frac{(E + p_z)}{(E - p_z)}$$

Proton acceptance in Central Tracker:
 $0.3 < P_T < 0.55 \text{ GeV}$
 $-0.3 < y < 0.3$

Central Tracker: $22^\circ < \theta < 150^\circ$

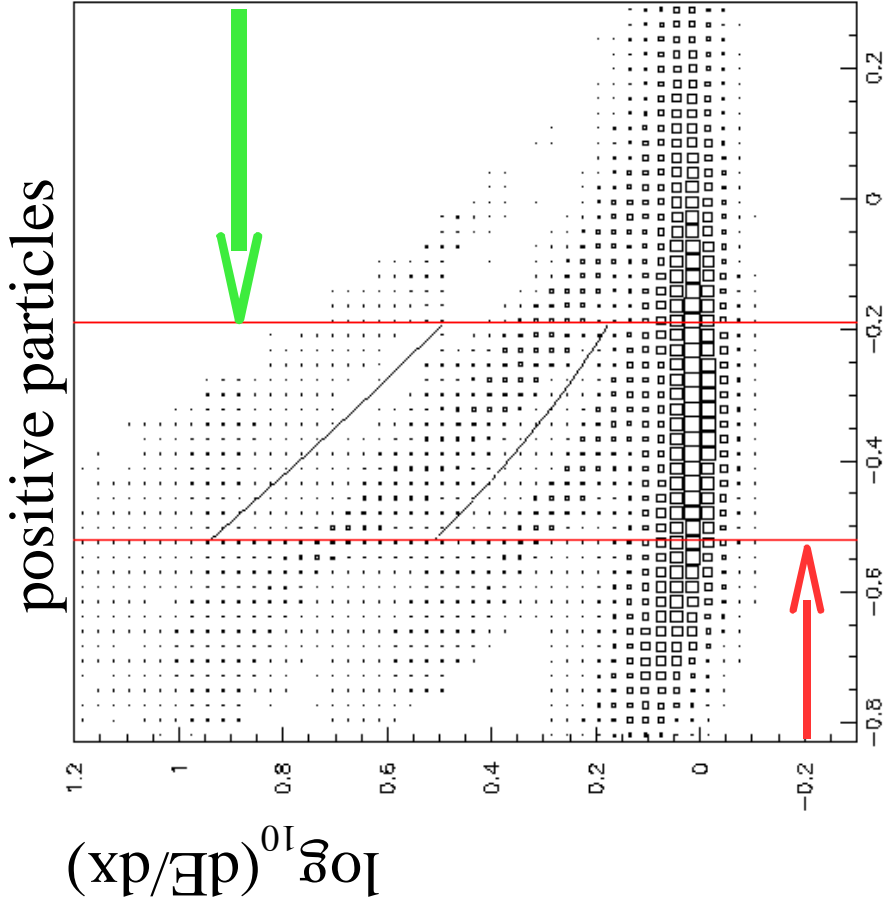
proton identification by $dE/dx \Rightarrow$ limits the momentum interval

$$\left\{ \begin{array}{l} 0.3 < y_e < 0.7 \\ Q^2 < 0.01 \text{ GeV}^2 \end{array} \right.$$

Scattered electron in electron tagger at -33 meter

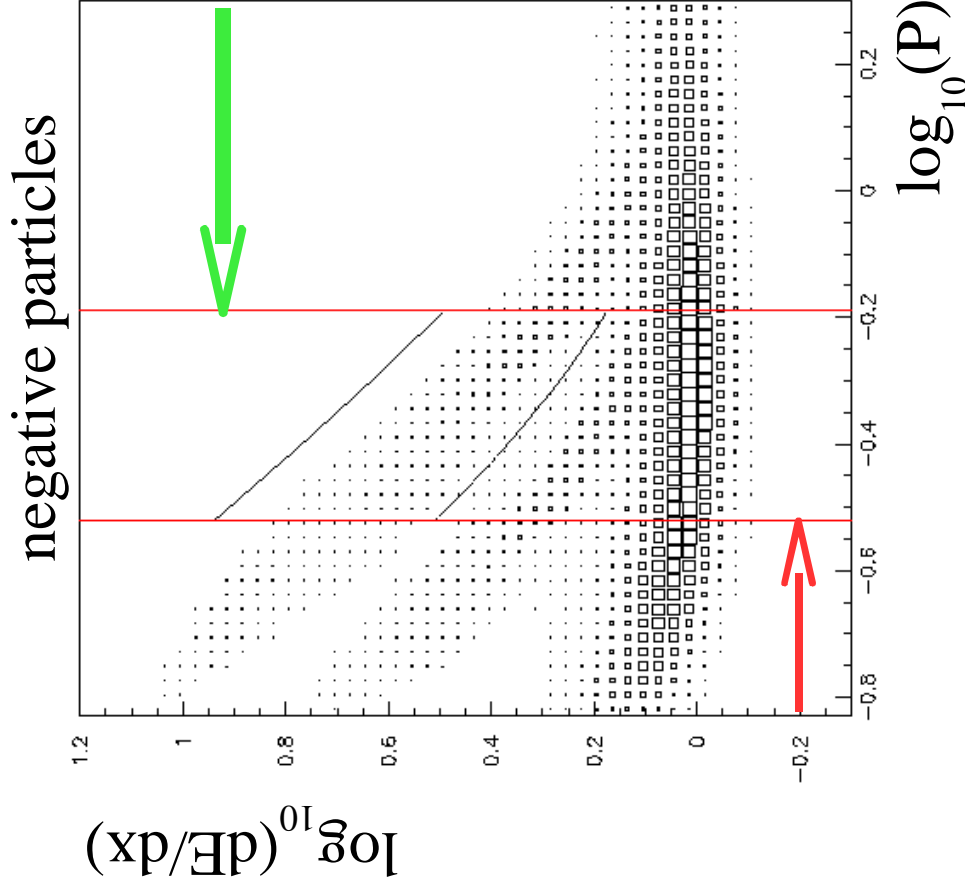
Trigger : multihadronic events (> 4 tracks in CT) & tagged electron

Identification of protons with dE/dx



at low momentum (<0.3 Gev) :

Large contamination of secondary protons
Large correction due to absorption in the
beam pipe

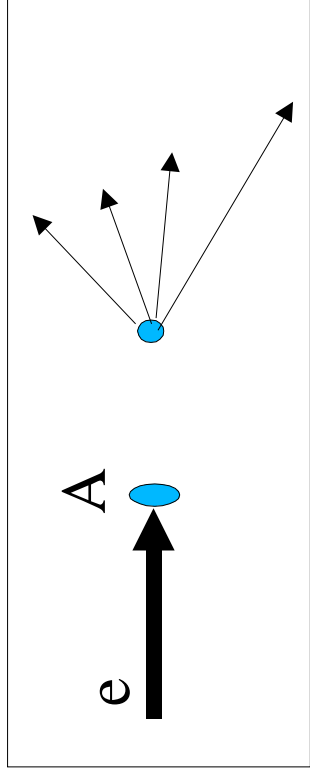


at high momentum (>0.65 GeV) :

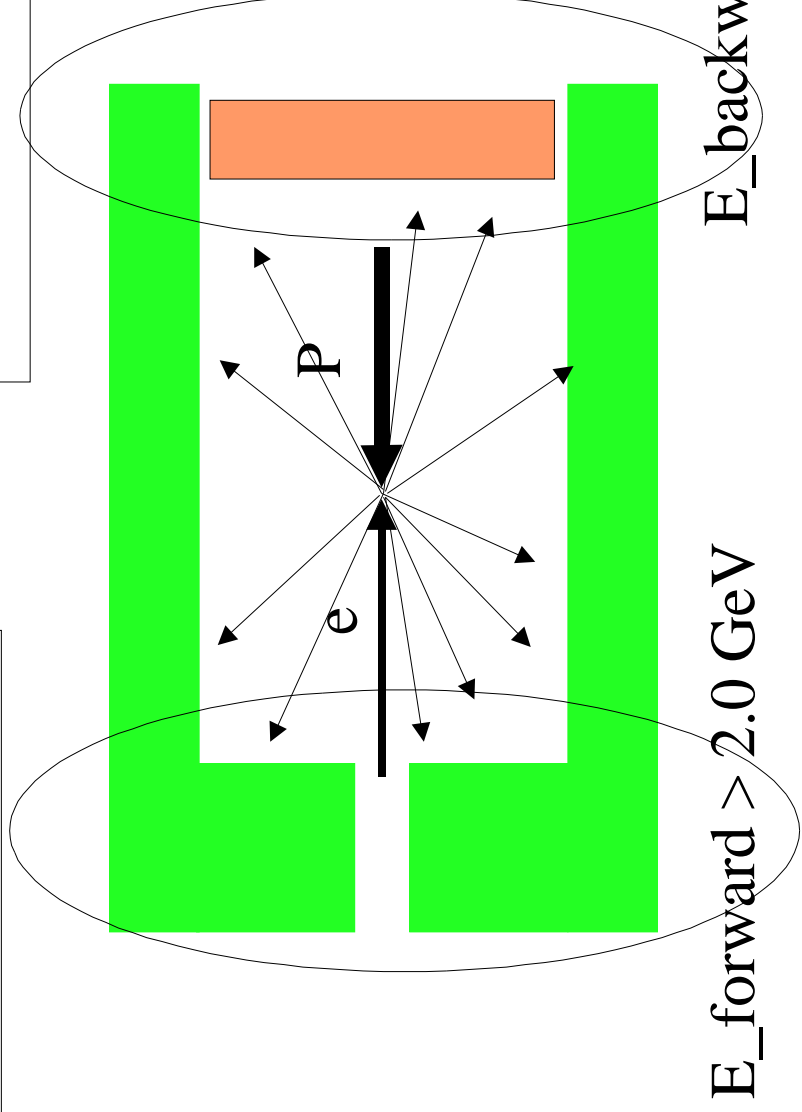
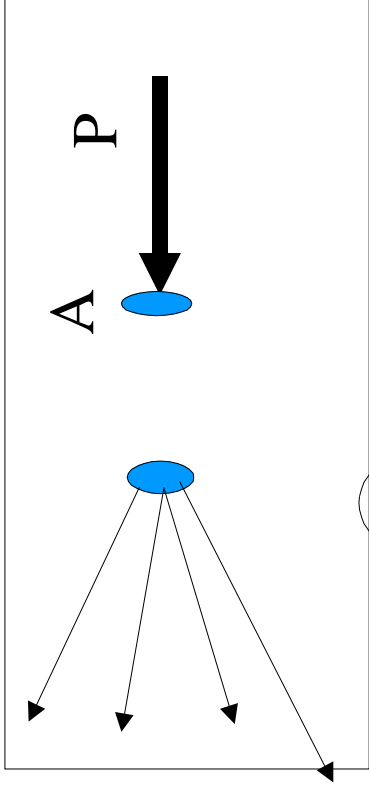
Contamination from charged π

Background from non-ep interactions

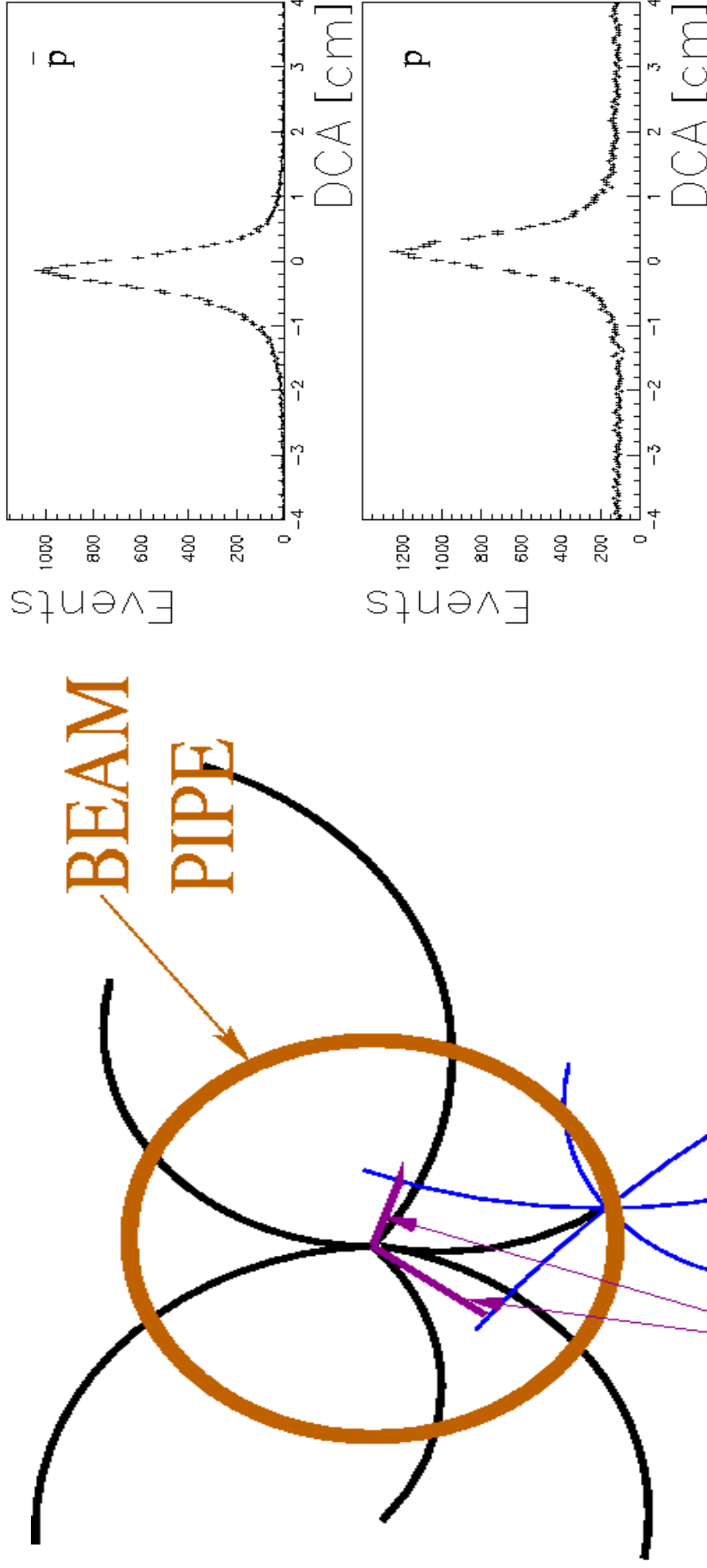
eA:



pA:



Secondary protons



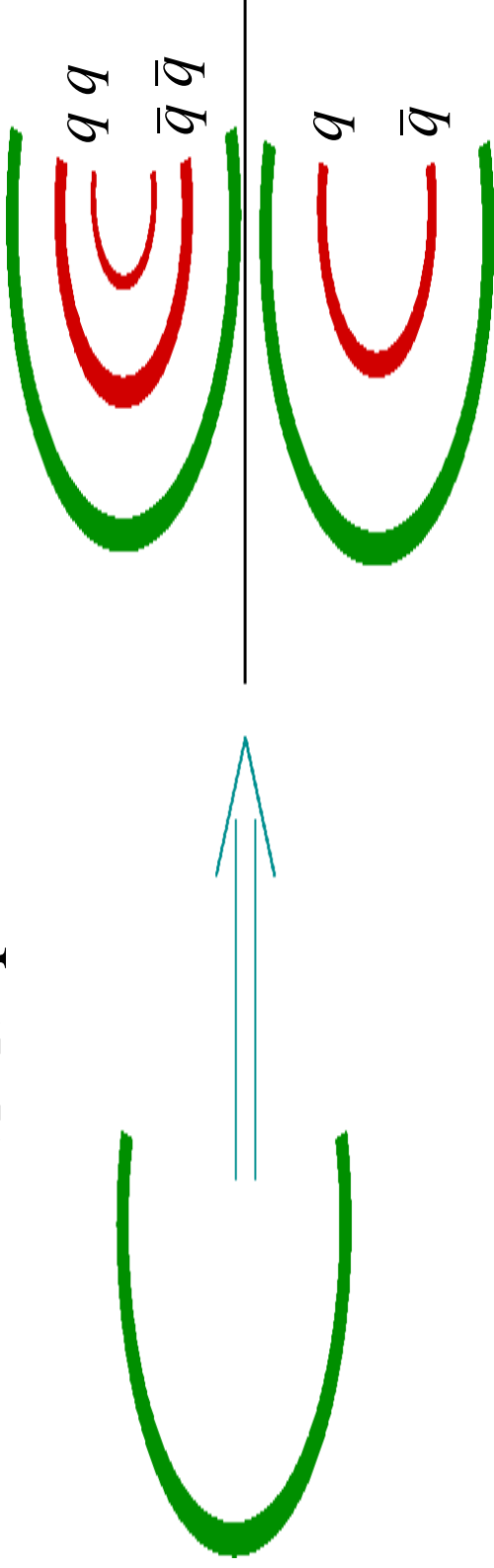
Distribution of the Distance of Closest

Approach to the primary vertex is different for the primary protons /antiprotons and secondary protons (from interaction of particles in the beam–pipe).

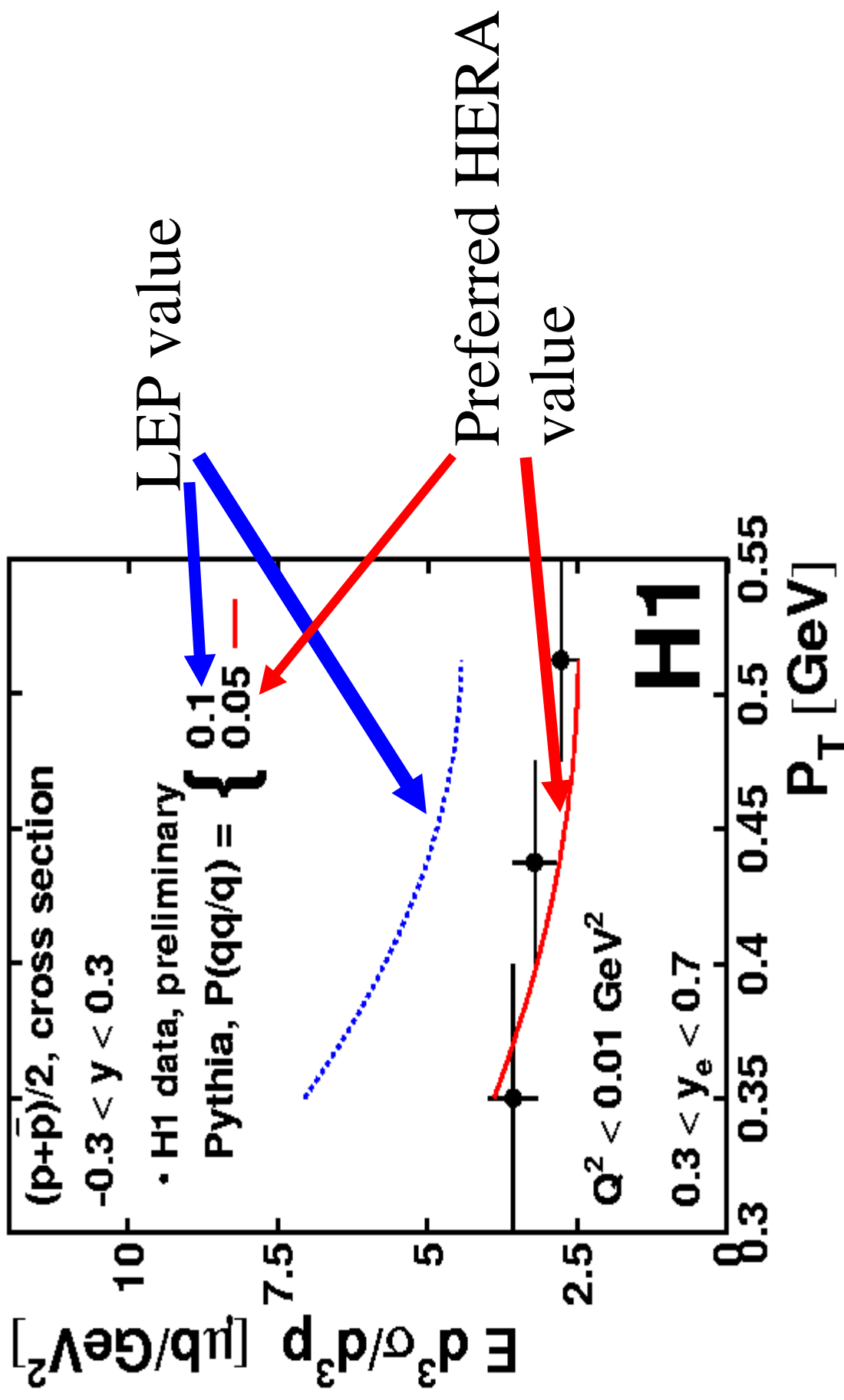
MC modeling

- PYTHIA to generate parton configuration before hadronisation
- **Lund string model** (implemented in **JETSET**) for the hadronisation step

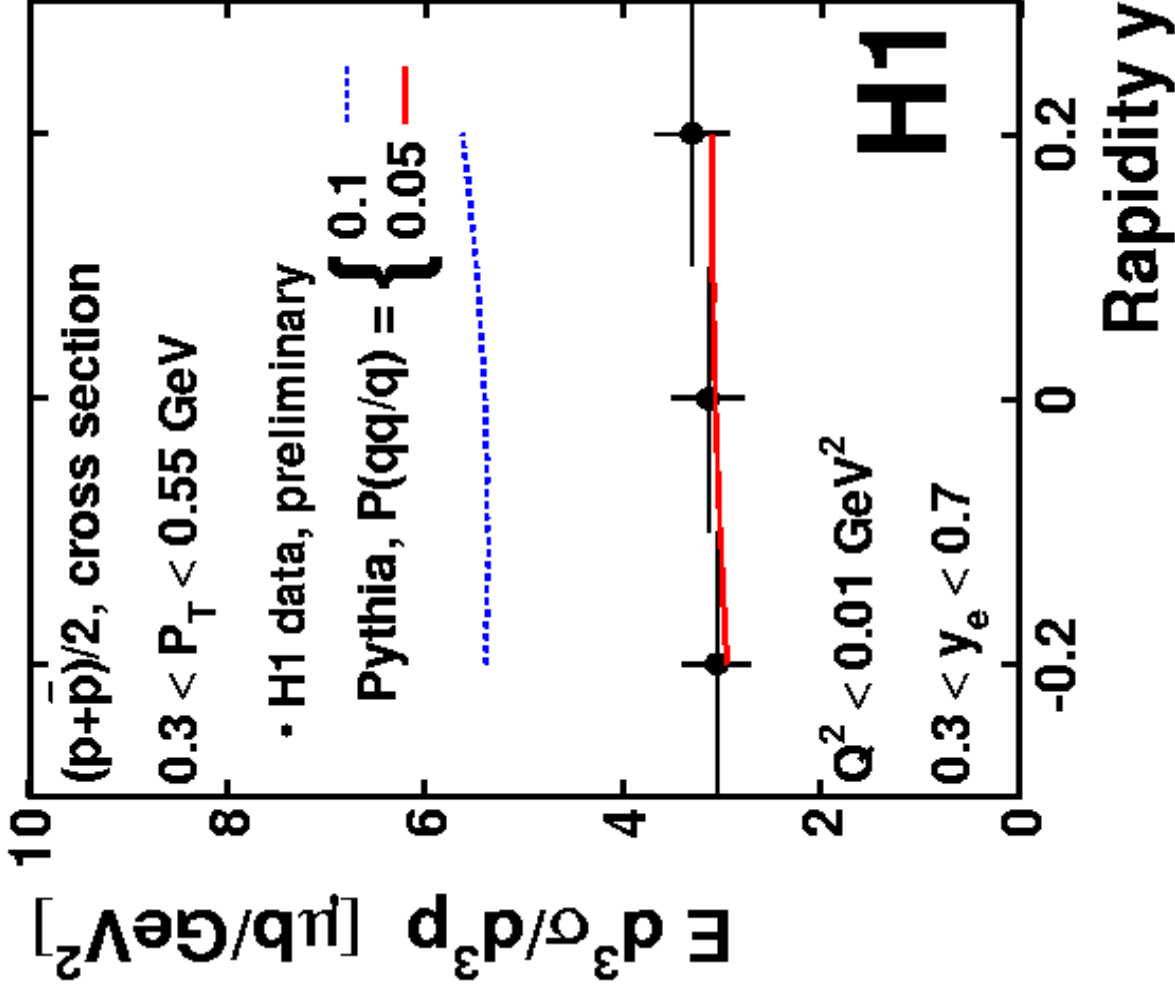
Sensitive parameter for the baryon production:
P(qq/q)—probability of producing a $(qq, \bar{q}\bar{q})$ pair relative to a (q, \bar{q}) pair in the colour field.



$E \frac{d^3\sigma}{d^3p}$: Dependence on proton P_T



$E \frac{d^3\sigma}{d^3p}$: Dependence on proton rapidity



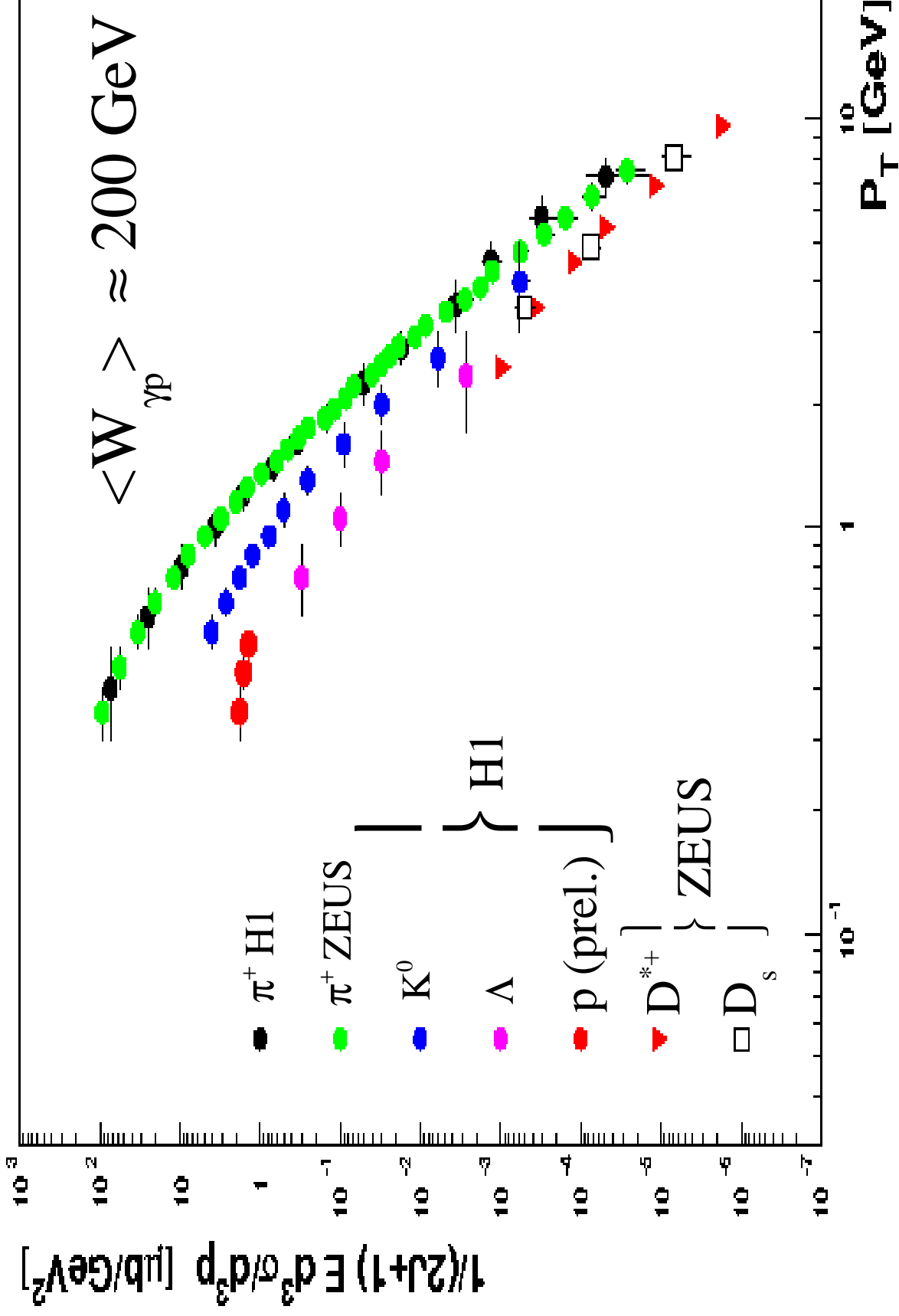
Good description of the shape of

P_T and rapidity

Both shape and yield described if the probability

$P(qq/q) \approx 0.05$

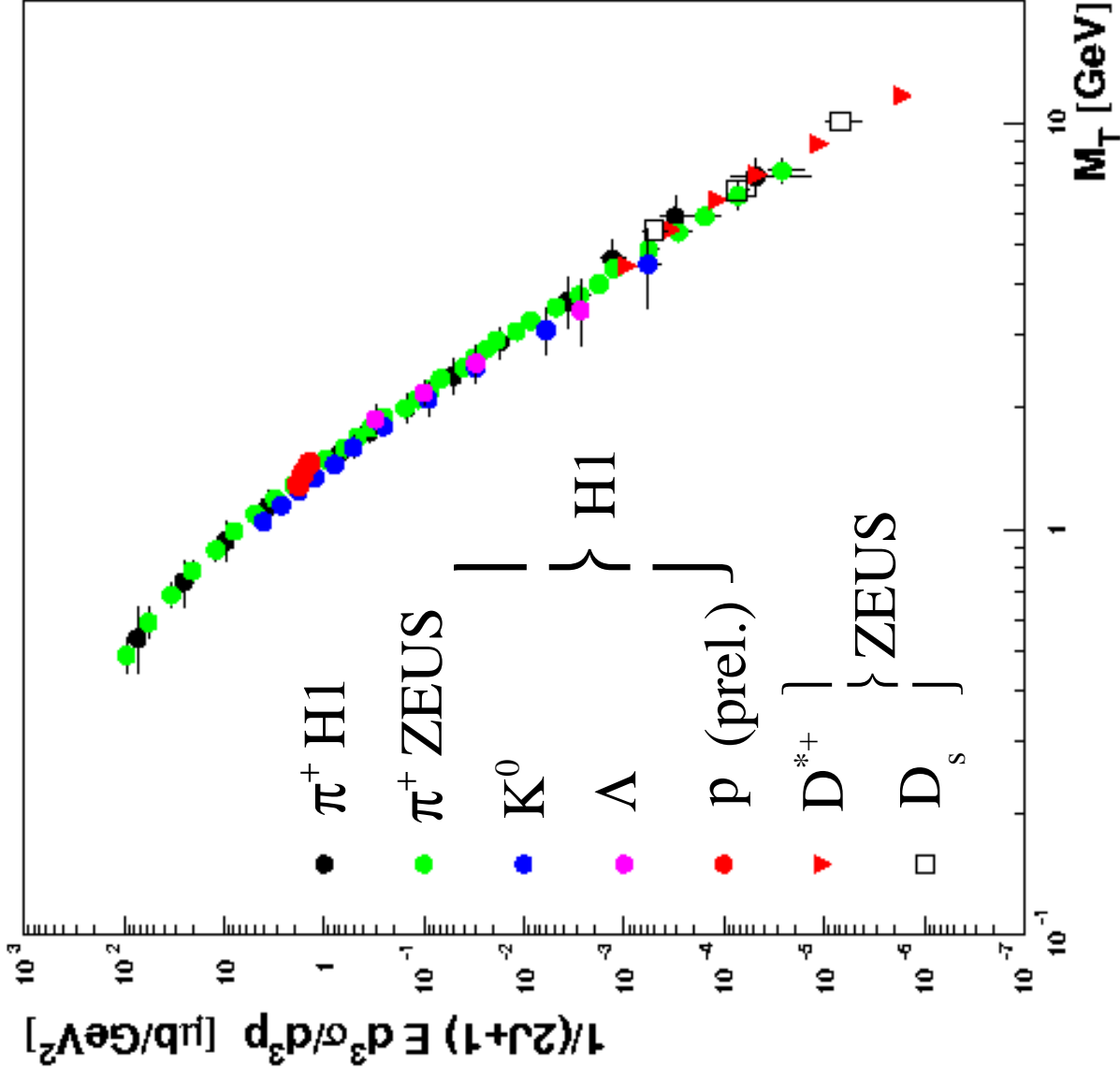
HERA γp : identified particle spectra (P_T)



Identified particle spectra (M_T)

$$P_T \Rightarrow M_T = (P_T + M)$$

Thermodynamical
model at work?



Summary

- Production of low energy protons in the central fragmentation region at HERA is studied for the first time.
- **PYTHIA + JETSET** describes the data well, using a probability $P(qq/q)$ which is a factor 2 smaller than found in e^+e^- collisions at LEP.
- Similar production cross-section for many particle species as function of M_T